BUSINESS ADMINISTRATION

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Titles	*Authors*
BUSINESS PSYCHOLOGY .	HUGO MÜNSTERBERG, Ph.D., M.D., LL.D. *Harvard University*
PERSONAL EFFICIENCY, APPLIED SALESMANSHIP, AND SALES ADMINISTRATION	IRVING R. ALLEN *Sales Counselor*
BUSINESS LAW I	SAMUEL D. HIRSCHL, S.B., J.D. *Member of the Illinois Bar*
BUSINESS LAW II	
BUSINESS ENGLISH . . .	EDWIN HERBERT LEWIS, Ph.D., LL.D. *Lewis Institute, Chicago*
BUSINESS ECONOMICS . .	ERNEST LUDLOW BOGART, Ph.D. *University of Illinois*
INDUSTRIAL ORGANIZATION AND MANAGEMENT .	HUGO DIEMER, M.E. *Pennsylvania State College*
MONEY AND BANKING . .	HENRY PARKER WILLIS, Ph.D. *Secretary, Federal Reserve Board*
INVESTMENTS AND SPECULATION	LOUIS GUENTHER *Editor, "Financial World"*
ORGANIZING A BUSINESS .	MAURICE H. ROBINSON, Ph.D. *University of Illinois*
FINANCING A BUSINESS . .	ELMER H. YOUNGMAN *Editor, "Bankers Magazine"*
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CREDITS AND COLLECTIONS	EDWARD M. SKINNER *Manager, Wilson Bros.* R. S. WHITE *American Steel & Wire Co.* H. E. KRAMER
TRANSPORTATION AND TRAFFIC	I. L. SHARFMAN, Ph.D. *University of Michigan*
OCEAN TRAFFIC AND TRADE	B. OLNEY HOUGH *Editor, "American Exporter"*
ACCOUNTING	HENRY PARKER WILLIS, Ph.D.
OFFICE ORGANIZATION AND MANAGEMENT	C. C. PARSONS *Manager, Shaw-Walker Co.*

LASALLE EXTENSION UNIVERSITY

INDUSTRIAL ORGANIZATION AND MANAGEMENT

HUGO DIEMER, B.A., M.E.
Professor of Industrial Engineering, Pennsylvania State College;
Consulting Industrial Engineer; Author of *Factory Organization and Administration*

La Salle Extension University
Chicago
1915

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INDUSTRIAL ORGANIZATION AND MANAGEMENT

CHAPTER I

THE PRINCIPLES OF BUSINESS ORGANIZATION

ORGANIZATION, ADMINISTRATION, AND CONTROL

Organization is the development of an organic structure, that is, a structure composed of organs. The term "organ" signifies a part which is a natural division in an animal or plant, capable of performing some special action essential to the life of the whole. The term "industrial plant" is a figure of speech which illustrates the analogy between industrial activity and natural life.

An organ in a mechanical contrivance is a component part performing an essential office in the work of the mechanism. In the steam-engine, for example, the cylinders, valves, cranks, etc., are organs. To develop an organic structure, therefore, we must arrange the parts so that each has a natural and specific function, office, and relation. A business organizer pursues the methods of the scientist in gaining an insight into the nature of the whole, basing his work upon a careful examination of all the parts and their interrelations.

Organization determines the scope and limits of activity of each individual or group of individuals in a business or industrial undertaking, together with their relations and connections with one another. Organization is the

chief source of power of large corporations. It means that the experience, technical skill, tact, and abilities of all kinds of carefully selected men are directed in such a manner as to be most effective in the interests of the business.

The act of managing or directing an organization is designated by the term "administration." The term is synonymous with "management." By management we mean the carrying-out or executing of the laws of the organization. Organization has already been seen to be based on the methods of science. On the other hand, management comes more nearly in the field of art. Management requires guiding by careful or delicate treatment. It involves a knowledge of all the human characteristics, prejudices, and affiliations of the individuals and groups of individuals composing the organization, together with the power successfully to cope with these characteristics, prejudices, and affiliations. It brings all of the individuals into harmonious relations and subservience to the laws of the organization.

The term "control" is used to designate the methods by which the executive or managing heads of a business carry out their authority to regulate its affairs in accordance with the laws of the organization. Control may be of the following types: (1) line control; (2) line-and-staff control; (3) functional control; (4) committee control.

Line Control

The term "line" in military usage means a row of men abreast of one another. In military line control the plan of campaign is not disclosed by the commander-in-chief to the line officers. Previous to the development of the modern system of staff officers, the commander-in-chief planned out which way the divisions should march, where

they should seek shelter, how they should be provisioned, where bridges and roads were to be built, etc., and he gave his orders at the proper time to the line officer next below him in rank, who in turn passed the orders to other officers down the line.

In line control as applied to industry, each foreman is responsible for everything in his own department or shop. He must see that the proper sequence of work is observed, that he does not run out of orders, that he keeps up with the work in hand, that he is provided with the necessary materials, supplies, and tools, that he is not extravagant with these, that the work is correctly done, that it does not cost too much, that his men are satisfied, and that his machines are in good working order.

Line control may be further illustrated by the divisional organization employed in many railroad systems. In divisional control the division superintendent is given absolute authority over the methods of his division in all lines, being held responsible only for results. This type of line control is also found in some large manufacturing plants. For instance, in an agricultural machinery manufacturing plant divisional control would give to the respective shop superintendents absolute authority as to methods, wages, and manufacturing policies, so that the superintendent of the mower department might use methods entirely different from those of the superintendent of the thrashing-machine department, and the superintendent of the gray-iron foundry might use methods of handling labor quite other than those of the superintendent of the malleable-iron foundry.

Line-and-Staff Control

Cæsar and Napoleon employed line control. It was von Moltke who developed the staff principle. He ap-

pointed special officers to furnish expert guidance, each staff officer having a field in which he was specially trained and expert. Thus, one member of the staff supervised engineering features, another the commissary, etc. As industry began to avail itself of the expert knowledge of men with special training and ability—for instance, in the fields of engineering and chemistry—we find business owners and managers employing staff specialists in these subjects. In military line-and-staff control and in its industrial analogy we find the staff officers and their assistants working out special problems and making their recommendations to the chief, who issues orders molded by the expert advice of his staff, through his line officers.

Functional Control

This type of control does away with all of the commissioned-officer type of foremen and assistant superintendents, and retains only one head at the top and gang bosses in the line. The staff control is extended to cover direct control of routine work instead of through the medium of expert advice to the chief line officials. In other words, the functional experts apply their expert knowledge not only to the formulating of rules, but to the regular course of business as it occurs each day, and each functional expert or boss deals directly with the men in the ranks, either personally or through the medium of expert instructors.

Thus, we may have functional experts assigned to the tasks of answering the following questions with regard to the regular work of a manufacturing establishment: "What work is to be done next?" "Where shall the work be done?" "How shall it be done?" The first question is answered by a functional head with a competent force of assistants who determine what shall be

the order of each day's work for each department and each man, and work out the system which will assign, at least a day in advance, each man's tasks for the following day. Such a functional force is sometimes designated by the term "bureau" to distinguish it from one of the processing departments of an industry. The name "order-of-work bureau" or "scheduling bureau" or "bulletining bureau" may be applied to such a functional division.

The question as to where the work shall be done can be answered by another functional bureau which knows all about the equipment and processes as well as the adaptability of men and tools to various kinds of work. Such a functional division may be designated as a "routing bureau."

The question as to how the work shall be done is made the subject of study by the men in another division who have specialized in the methods and the requirements of each job, and they prepare detailed instructions as to how work shall be done. Such a bureau may be designated as an "instruction bureau" or "instruction-card bureau."

Committee Control

The committee system involves the carrying-on of meetings of the officers of the business or shop at regular intervals. At these meetings, committees appointed to take charge of specific functions, as well as special committees which act from time to time on matters of new methods and policies, make their reports. It has been claimed that in industry and business as well as in private life there should be no attempt at government without the consent of the governed, and the advocates of democracy in business and industry claim that the com-

mittee system is most productive of loyalty and intelligent co-operation.

Committee meetings afford an opportunity for discussing methods proposed by staff specialists or line officers, and give the chance for looking at these proposals from various angles. They afford an opportunity for adverse critics to express themselves and at the same time give the proposer a chance to defend his schemes. These meetings provide also an opportunity for the various heads to get better acquainted with each other and to recognize the good points in each other's characters. Whether the control be line, line and staff, or functional, the committee system is applicable.

Among the purposes of various committees which report to the general meeting of officers, we may cite the following as representative:

1. The manufacturing committee, which decides on the manufacturing program, determining what stock of manufactured product and parts shall be built, and discussing the general status of orders from customers and summarized reports from the order-of-work bureau.

2. The tool committee, which determines on new tools, considering whether the conditions justify them or not and selecting the most important ones. This is an important matter in a seasonal business such as automobile-building, where cheapness of production, rapidity of getting out new styles, and interchangeability depend largely on the adoption of tools that can be built quickly by a department which under no circumstances can hope or expect to get out a complete set of tools before the current season is over.

3. The suggestion committee, which considers all suggestions as to improvements and decides on the awards for the best suggestions, as well as ways and means of

keeping the suggestion system up to a state of high efficiency.

4. The safety committee, which will make recommendations for safeguarding machinery and for providing conditions favorable to the health and physical well-being of employes.

5. The welfare committee, which can consider such matters as social activities, athletics, library, home betterment, etc.

6. The educational committee, which will consider the apprenticeship system and methods of providing specialized education for all classes of employes, so as to make them more effective in the business.

7. The committee on new designs or new products.

8. The committee for considering cost reductions and economies in general.

9. The committee on complaints.

Types of Control Compared

Line control is avowedly autocratic. It demands unquestioning obedience to the line officer. The matter of obtaining results is put up to each succeeding lower officer in the line by the officer at the top. The danger is that the lowest line officer is apt to put it up to the men in the ranks to get results in a variety of activities. Line control demands the greatest degree of all-round ability on the part of each officer and each man in the ranks.

Line-and-staff control recognizes the value of special education and training and accepts the advice of specialists. On the part of line officials there is apt to be a considerable amount of mental reservation as to the desirability of certain staff recommendations coupled with frequent failure to carry out the recommendations of the staff. However, there is no question but that it is a great

advance over the all-line type of control and has superseded the latter in practically all industries requiring expert engineering and chemical skill, such as the steel industry and chemical manufacturing.

Functional control brings the expert guidance into immediate touch with the worker, as applied to his daily routine. Functional control is apt to be strenuously resisted by the incumbents of positions of authority in the old line organization, who resent interference with their autocratic authority. It is unquestionably coming into wider use in our industrial undertakings, since in almost every large industrial center we find factories in which such matters as routing, scheduling, and instructions to men are being taken care of by functional bureaus.

Specialization

It has been truly stated that the two great underlying principles of modern industry and business are combination and specialization. The combining of small undertakings into large ones naturally paved the way for minute specialization. In the administrative field of business we find the principle of specialization first appearing in the division of management under three headings, namely, producing, selling, and accounting.

On the production side we find the principle appearing in the departmentalization of factories. The first natural division of a metal-working factory was into foundry, forge-shop, pattern-shop, and machine-shop, with the designing and drafting done by the superintendent and assistants. This division was followed by distinct designing and drafting departments, separate departments for distinct processes in the machine-shop, such as lathe department, drill-press department, screw-machine department, etc.

With the expansion and enlargement of shops we find the work of the individual workman becoming more specialized and restricted. The all-round mechanic has become practically obsolete. As a result strong efforts were requisite to develop courses of training to counteract the harmful effects of over-specialization. Continuously performing the same task has been found to deteriorate rapidly the body and mind of the worker. It has been claimed that the loss due to this rapid deterioration, which means a lessened earning power, is greater, from the public point of view, than any gain the consuming public has made by the greater speed and cheaper pay of men kept at a single operation.

Specialization and Functionalization Contrasted

Functional control must be clearly distinguished from specialized departmentalization. Functional control means the selection of some feature of the work common to all departments, and placing the control of this feature in the hands of those men in the existing set of employes most capable in that special feature. The special features here referred to are those relating more particularly to planning, inspection, repairs, and speed of machinery, and not to technical processes peculiar to individual departments.

It has been truly said that the all-round man does not exist. A man may be a fairly good all-round mechanic, but it is likely that, if his mechanical skill is pronounced, he will be lacking in certain desirable mental qualities essential to successful planning of work. Some foremen and some men in the ranks have the mental characteristics that peculiarly fit them to be engaged in scheduling or order-of-work activities. To others such work is distasteful, while they might be remarkably well

adapted to work connected with accuracy or inspection. Others would not have the characteristics necessary to excel in either of the above-mentioned features, but would be admirably adapted to finding out the greatest speed which may be used without fatigue, and with due allowance for necessary periods of rest.

For this last-named function, men who have the reputation of being drivers, or who are not well liked by the workmen, would not do at all. Functionalization, it is evident, is important in the matter of control. Specialization is important in departmentalizing a business or industry in accordance with the materials and processes which naturally form a distinct division. Specialization is the natural outcome of the merging of small businesses into larger ones.

Combination

One of the causes for the study of principles of organization as applied to business and industry has been the tendency toward combination, aggregation, integration, or consolidation of businesses. Such integration may be partial, if it affects only one of the leading production factors, such as the selling end, or selling and producing, or it may be complete, if it affects the source of raw materials, the transportational facilities, the production, and the selling. An example of almost complete integration of production factors is afforded in the organization of the large steel companies. In the oil companies we have another example, although the raw-material sources are frequently leased in this industry. Naturally the planning of the organization for a given business or industry is affected by the extent to which combination of production factors, and of various smaller business units, enters into the problem.

Classes of Industry

Industry is broadly divided into the following classes: (1) producing, (2) transporting, (3) financing, (4) distributing.

In the producing class we have agriculture, mining, and manufacturing. In transportation we have railways, steamship companies, canals, express companies, and local delivery companies. In financing we have banking, insurance and bonding companies, stock exchanges, and bond houses. In distribution we have wholesalers, jobbers, brokers, and retailers.

Manufacturing industries are classified according to their processes as analytic or synthetic, and as having consecutive, simultaneous, or intermittent processes, or combinations of these. Analytic manufacturing separates a raw material into its constituents, selecting and assorting them as leading products, by-products, and waste. The lumbering business is an example of this type. Synthetic manufacturing builds up a compound product out of simple raw materials. An example of this last-named type is furniture-building. Consecutive processes are apparent in a cement mill, a hat factory, or a wall-paper factory. Simultaneous processes are apparent in an automobile factory.

System

System is a term applied to the methods by which the objects of the organization are carried out in an orderly way. We organize to manage, and we manage largely through system. The characteristics of good system are simplicity and efficiency. When system is lacking in these characteristics, it is well named "red-tape."

Having planned an organization and determined on the activities, authorities, and limits of action of each individual and group of individuals, we prepare a series of ways and means for securing results as planned. These methods, when arranged according to a logical, scientific, and orderly plan, constitute system. A man may be a good systematizer, and yet not be a good organizer, and even a poor manager. The man who aspires to rise higher than a systematizer must make system his servant and be ever watchful lest the situation be reversed and he become system's slave.

Efficiency

By efficiency we mean the ratio of output to intake. For instance, an electric motor of 85 per cent efficiency gives out only 85 per cent of the horse-power value of the electricity delivered to it. In speaking of the efficiency of a cost system or production system, we are comparing the net useful worth of the results secured through such a system with the total cost of operating the system in the way of salaries of clerical and administrative employes, cost of stationery, and first cost and depreciation in value of furniture, fixtures, and mechanical appliances required to carry out the system.

A system devised for a specific industry and organization can rarely be applied to another industry or to a different type of organization in the same industry. It is the sure sign of an amateur to be a "form-collector" and to spend more time in devising the details of card indexes, loose-leaf files, and storage cabinets than in studying and mastering principles. On the other hand, it is equally the earmark of the ignoramus and reactionary to decry all principles of organization and all orderly methods as "red-tape."

Correct Use of Technical Terms

The preceding discussion has laid stress on defining the meaning of certain terms. The dictionary and encyclopædia give us definitions of terms in several ways. They usually lay greatest stress on the meaning of the terms when used in their most commonly accepted popular sense. They give us also the meaning of these terms when used in a technical sense. For instance, when used as a technical legal term, a word has a different meaning from that which it conveys in its most general popular use. Business and industrial management, as they have developed into sciences, have adopted certain words in a technical way in just the same manner as legal science has done.

For the sake of uniformity of expression and mutual understanding, it is therefore necessary for the student of business and industrial management to familiarize himself with the technical meaning of the terms used in his profession and to use them in the same sense and with the same meaning as they convey when used by men who are the leaders in his profession. Hence, the beginner is advised to study carefully the terms used in this and the following chapters. They have been carefully selected with a view to representing the most generally accepted expressions of correct present-day usage. There is a tendency among narrow-minded men who have made a mistake in the employment of terms to say, "Well, we use that word here to mean something else." The danger of insistence on a different meaning from the generally accepted one is that it will confuse new employes, auditors, and other members of the organization.

Developing Organizing Ability

As promotion to positions of responsibility frequently hinges on the reputation of being a good organizer, it is worth the while of every ambitious worker to know something about how to develop organizing ability. The first requisite is a keen interest in one's duties, coupled with strict self-discipline in performing one's assigned routine tasks in accordance with directions of superior officers.

There will always be room, however, for the individual to show ability in systematizing materials and tools in an orderly and sequential way, whether his work be mechanical or clerical. The manner in which a clerk keeps his pens, ink, pencils, erasers, and current supply of stationery, and the orderliness of the drawers in his desk assigned him for his personal private use, may be made the subject of his careful thought.

No matter in how detailed a manner the routine work may have been specified by higher authority, there will always be found opportunities to systematize work as well as materials and tools. Naturally, the man who has supervision over several others will find a still wider field in which he can practice the development of organizing ability. In later chapters the human element in management will be dwelt on at greater length. For the present it will suffice to say that an agreeable personality which commands respect is important in the ability to organize men.

TEST QUESTIONS

1. Define organization. What are the aims of industrial organization?
2. How is an organization designed? Describe the analytical or investigational steps and the synthetic or constructive steps.
3. How is management related to organization?

4. What part does system play in relation to organization and management?

5. How do all-line control, line-and-staff control, and functional control differ?

6. Does committee control replace any of the other types of control, or can it be used in connection with them? What types of activities may well be conducted under committee control?

7. Do you consider military types of control necessary or advisable in industrial undertakings?

8. Contrast specialization and functionalization.

9. What are some of the leading general functions in an industrial undertaking?

10. From what classes of employes would you build up various committees?

11. How are industries classified?

12. What is the argument in favor of correct use of technical terms?

13. How may one develop organizing ability?

14. How does the human element enter into management problems?

15. Contrast departmentalization by product with departmentalization by processes.

16. In what way does the functional expert apply his specialized knowledge to the regular running production routine to a greater extent than the staff expert?

17. In what way can principles of democracy and self-government be introduced into industry without injury to the interests of the proprietorship?

18. Which type of organization, military or functional, requires the most capable all-round supervisional heads and why?

19. How has the tendency toward larger industrial units due to combination and consolidation affected production factors?

20. Give some examples, drawn from your own knowledge or experience, of analytic industries, of synthetic industries, of simultaneous processes, of consecutive processes.

CHAPTER II

TYPES OF ORGANIZATION

Making Charts of Organization

The relationships between departments and the scope of activities and limits of authority of various officials and department heads are most clearly visualized through the medium of organization charts. Such charts usually represent the leading departments by rectangles or circles. These departments are then connected by lines showing their relationships to one another.

Charting Line Control

Figure 1 shows the application of charting to illustrate line control. An inspection of this chart shows that the board of directors (1) formulates certain policies which are carried out by the general manager (2), the latter being free to adopt such methods as he sees fit. The general manager has charge of three distinct divisions, these having to do with accounting, producing, and selling, and supervised, respectively, by the comptroller (3), the works manager (4), and the sales manager (5).

The works manager has jurisdiction over the production superintendents, namely, the superintendent of foundry (6), superintendent of forge-shop (7), and superintendent of machine-shop (8). Each of these superintendents has jurisdiction over a number of fore-

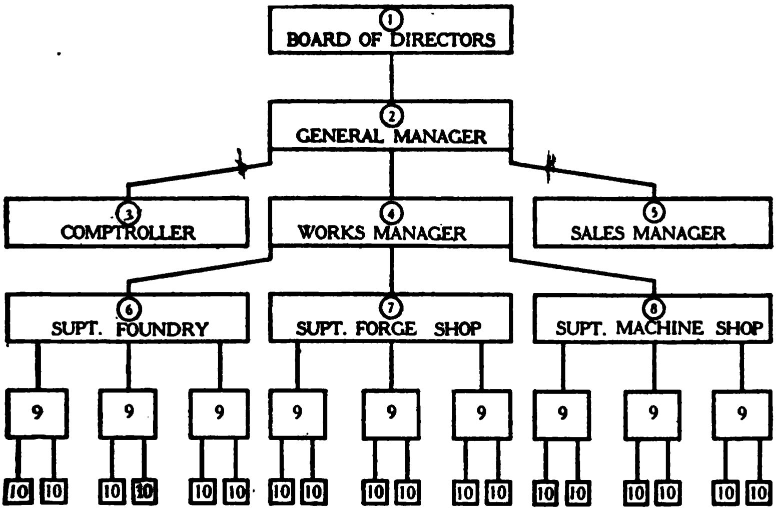

FIG. 1.—Chart Illustrating Line Control

Squares marked "9" represent department foremen.
Squares marked "10" represent gang bosses.

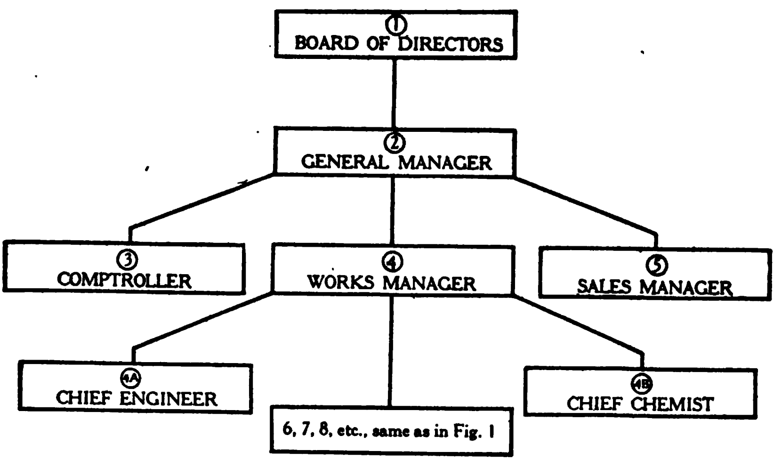

FIG. 2.—Chart Illustrating Line-and-Staff Control

Squares marked "4A" and "4B" represent the staff for expert guidance.

men (9). Each of these foremen has jurisdiction over a number of gang bosses (10), through whom orders are given to the men in the ranks.

Charting Line-and-Staff Control

Figure 2 shows line-and-staff control. In this type of organization we have the line organization identical with that shown in Figure 1. The works manager (4), however, is assisted by a staff consisting of the chief engineer (4A) with his force of assistants, and the chemist (4B) with his force of assistants. These staff officials report to the works manager on technical questions connected with their specialties.

Charting Functional Control

Figure 3 is a chart illustrating functional control. In this chart the works manager (1) exercises his control through the medium of the functional heads (2 to 9). These functional heads have charge of the following branches or bureaus: (2) order of work and routing; (3)

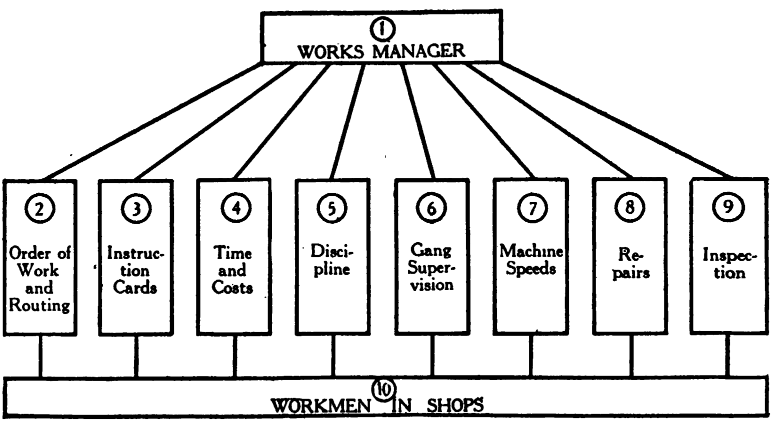

Fig. 3.—Chart Illustrating Functional Control

instruction cards; (4) time records and costs; (5) discipline; (6) gang and specialized department supervision; (7) speeds and methods of operating machinery; (8) repairs; (9) inspection.

These eight functional heads consult directly with the men in the ranks (10), either personally or through assistants, giving advice and instructions direct to the workmen.

Charting Committee Control

Figure 4 is a chart illustrating committee control in connection with functional control. The functional or-

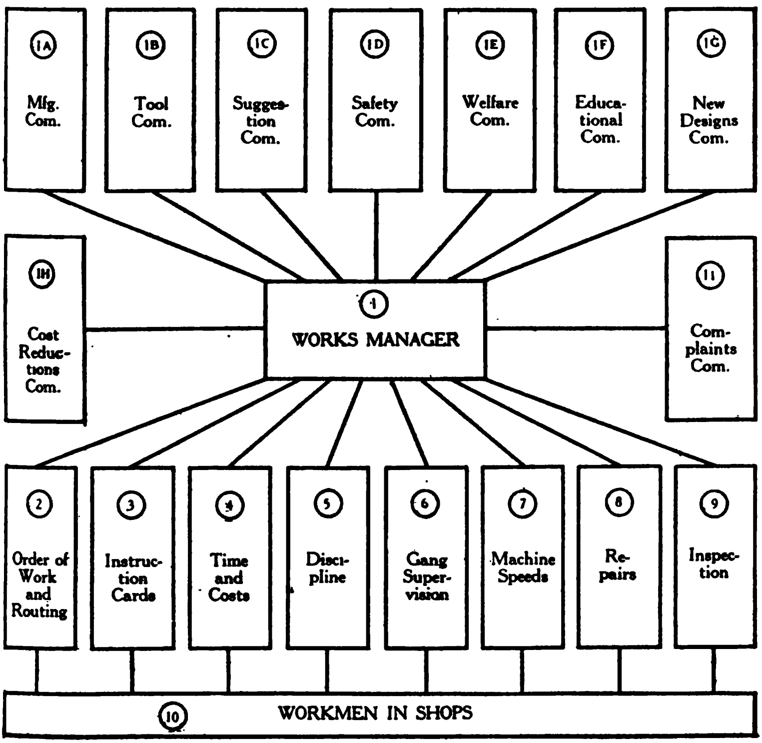

Fig. 4.—Chart Illustrating Committee Control over Certain Activities together with Functional Control over Shop Routine

ganization is identical with that shown in Figure 3. The works manager is, however, assisted by various committees, shown by circles *1A* to *1I*, inclusive. Of these *1A* represents the manufacturing committee; *1B*, the tool committee; *1C*, the suggestion committee; *1D*, the safety committee; *1E*, the welfare committee; *1F*, the educational committee; *1G*, the committee on designs or new product; *1H*, the committee on cost reduction; *1I*, the complaint committee.

Chart Illustrating Departmental Specialization

Figure 5 illustrates how departmental specialization is arranged for through the medium of distinct productive departments, each department being in charge of a foreman or gang boss who is a specialist in the processes indicated. In this chart the works manager (1) exercises supervision through the superintendent of the forge-shop (2), superintendent of the foundry (3), and superintendent of the machine-shop (4). The superintendent of the forge-shop controls the work of that shop through specialized foremen as follows: foreman of hand-forging (5), foreman of drop-forging (6), foreman of machine-forging (7), foreman of tool-forging (8).

The superintendent of the foundry exercises control over the foundry through the medium of the foreman of core-making (9), foreman of flasks (10), foreman of molders (11), foreman of cupolas (12).

The superintendent of the machine-shop exercises his control through the foreman of the machine-tool department (13), foreman of tool room (14), foreman of group assembly (15), foreman of erecting (16). The foreman of the machine-tool department exercises his control through certain gang bosses, such as lathe gang boss (17), planer gang boss (18), drill gang boss (19), etc.

The chart of departmental subdivision of a plant by processes (Fig. 5) may be supplementary to and entirely independent of a chart showing functional control, each

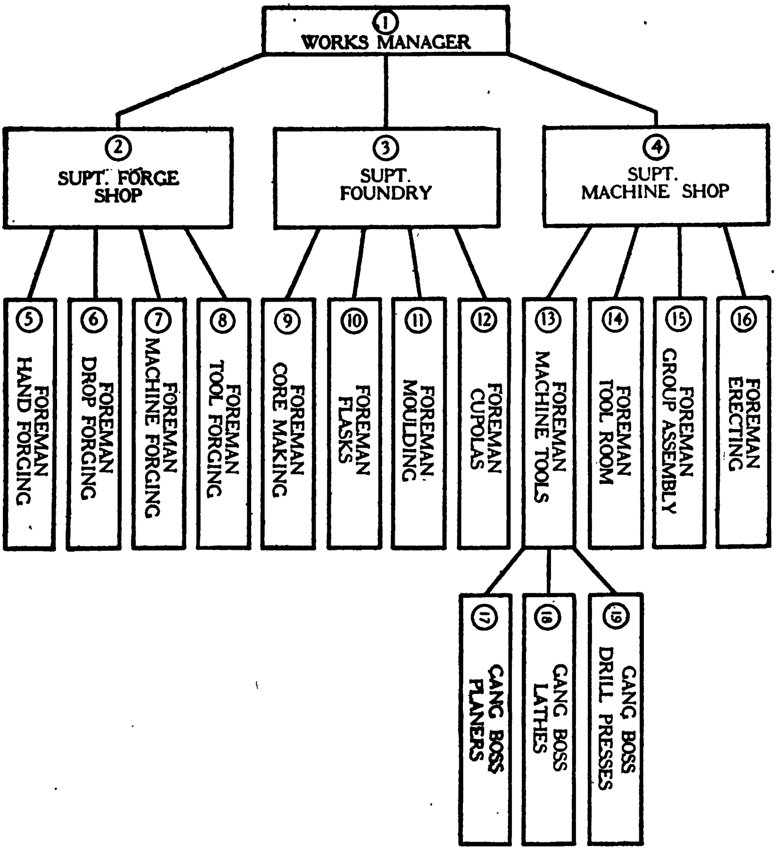

FIG. 5.—Chart Illustrating Departmental Specialization by Processes

of the various specialists occupying virtually the same position in the functional organization as the gang boss in Figure 4. In functional control the foremen's duties

do not include any of those assigned to the functional heads, but are confined to technical questions as to setting up work in machines and assisting the men to do the work in accordance with their instruction cards.

"Three-column" Type of Industrial Organization

The charts shown in Figures 1 and 2 illustrate what is designated as the "three-column" type of industrial or-

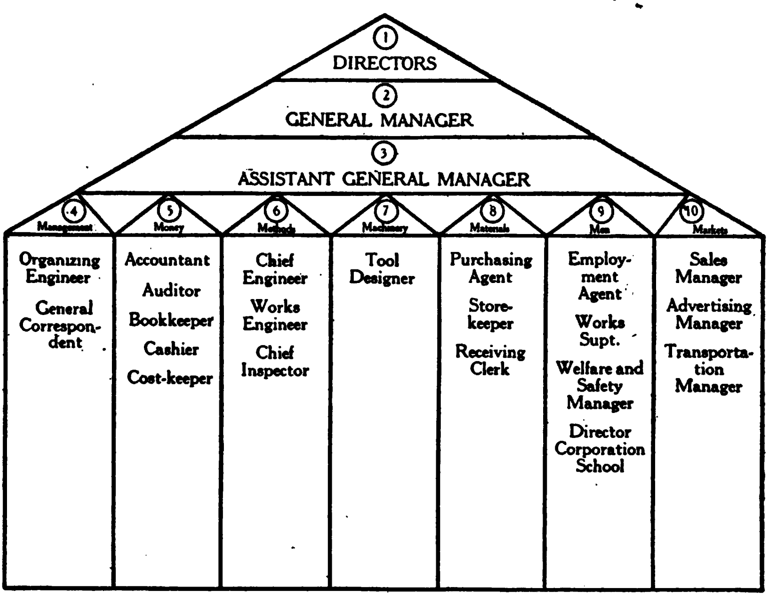

Fig. 6.—Chart Illustrating Organization Embodying Going's Principle of the "Seven M's"

ganization, in which the activities of an industry are divided into three distinct groups, namely, (1) production, (2) selling, and (3) accounting. This division is the most usual one, but it is by no means the only division, and it must not be assumed that other types of general or-

ganization which depart from this type may not be more effective under certain circumstances. Indeed, there has been a tendency to depart from the "three-column" type within recent years.

The Seven M's

Charles B. Going advocates organization under seven distinct headings. For easy memorizing of these heads he uses a word beginning with M for each, namely, Management, Materials, Men, Machinery, Methods, Money, and Markets. Figure 6 illustrates a type of organization in which these seven factors are made the underlying basis. An organization of this kind is in use at the Remington Typewriter Works, and has proved entirely satisfactory.

Charting Progress of Orders

Charts are sometimes advantageously employed to show the progress of an order through various departments. Figure 7 shows such a chart. An examination of this, beginning at the top, indicates that the order is first received by the sales department, whence it passes to the works manager's office, where the order is entered, and from which three groups of activities connected with the execution of the order are put into action. On the left-hand side the order passes through the designing department, which in turn passes it to the drawing department for the making of such drawings as are needed to supplement any new designs or for the requirements of the shop. Thence it passes to the inspection department whose duty it is to inspect materials, work in process, finished parts, assembly groups, and erecting. When the work is finished, it is tested by the testing department,

which must also receive a copy of the order and specifications.

Following next the right-hand path, we find that the

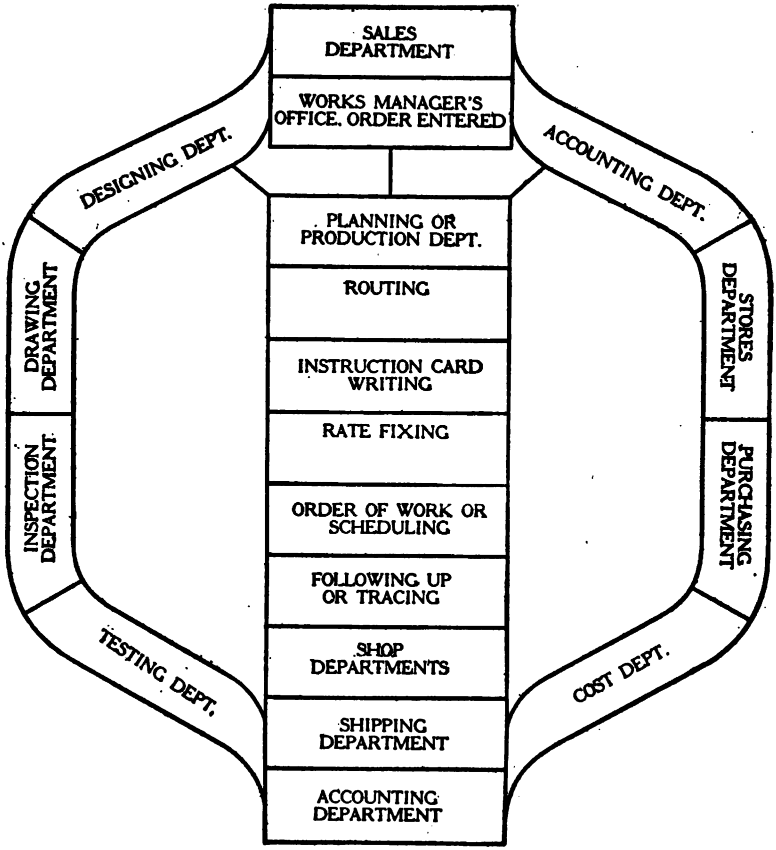

FIG. 7.—Chart Illustrating Progress of an Order through Various Departments

This type of chart may be made in the form of the hot-water bottle, as shown, or other convenient shape.

accounting department has received a copy of the order, the connecting line between the accounting department

and the production department showing that the latter provides such information as is required by the former in reference to stores and materials to be purchased for the order. The accounting department passes the order to the stores department, where an analysis of the bill of material is made and the balance-of-stores records checked up to indicate what materials and parts are on hand and those which have to be made in the shop, the production department being notified of the results of this accounting. Next, the purchasing department receives from the stores department the information as to what purchases need to be made by reason of the entry of the order. Next, the cost department is notified of the order and its status as to parts to be drawn from stock, parts to be purchased, and parts to be built in the shop.

Following the center path, we find the planning or production department receiving the order simultaneously with the designing department on the left and the accounting department on the right. The planning department at once starts another set of activities requisite to the expedition of the order through the shops. As indicated, these activities pertain to the routing of the order through the shop departments, the getting ready in advance of detail instructions as to the making of each piece and group and putting them together. Next comes the work of rate-fixing or the establishment of such inducements or rewards in the way of premiums, bonuses, or piece rates as will be offered in connection with the order. Then comes the proper placing of the various parts required in the shop's program of work, after which each part and group and the order as a whole is followed up or traced as it progresses through the shop. Finally,

the various sub-orders must be delivered with all instru tions to the various shop departments.

Looking at the lower part of the chart, we see that th work of the shop, including the completion of the wo of the planning department's branches, is finished simu taneously with the work of the testing department o the left-hand or technical engineering branch, and wit the work of the cost department on the right-hand o accounting branch. The order now passes to the shipping department, and after shipment, all data go again to th accounting department for billing and determination o the profit or loss on the order.

FORM OF GRAPHICAL CHART TO INDICATE PROGRESS OF ORDERS

The example just given is arranged in a manner which has been designated as the "hot-water bottle" type of chart. Other striking forms which may be used for this purpose are charts in the form of an hourglass or drawn up so as to imitate the lines of the nervous and circulatory system of the human body. For the most part these devices are merely "catchy" talking-points used by professional systematizers.

The best way to arrange such a chart is to cut out pieces of paper in the form of circles or rectangles, a separate piece of paper being prepared to represent each separate department which has anything whatever to do with the handling of an order. Next, cut out a number of long, narrow strips of paper to serve as connecting paths between the circular or rectangular templets already cut out. Now, connect the various departments in proper sequence when considered from the viewpoint of progress of orders, grouping together such departments as come under one general supervisory heading. After this arrangement has been made, you can change the

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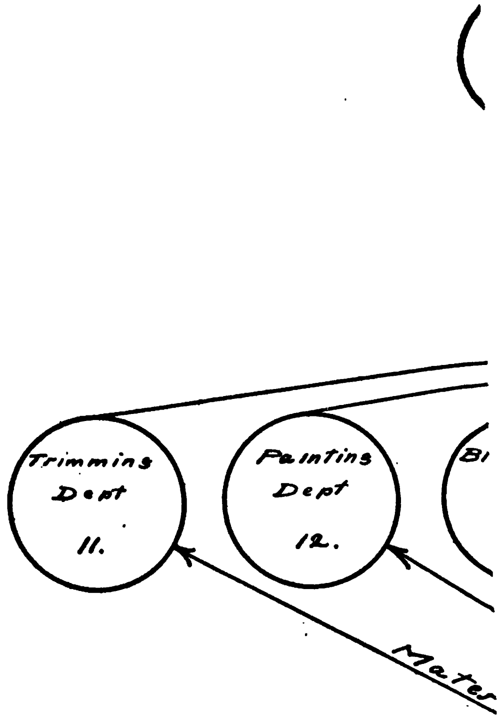

proportions of the circles or rectangles in such a way as to make a symmetrical chart. A little artistic temperament and imagination will enable you to construct out of the chart almost any kind of picture desired, if you want to make it "catchy."

Indicating Paths of Material on Charts

By making comments in condensed form along the lines connecting the departments after they have been arranged in the form best adapted to showing the progress of an order, we can utilize the chart not only to indicate the progress of the various papers connected with the execution of orders as they pass from department to department, but we can also make it indicate how the raw materials, work in process, finished parts, and groups flow from department to department.

Figure 8 is an illustration of such a chart as prepared by the author when he was superintendent of an automobile factory. This chart proved to be very useful in training the various store-room assistants, timekeepers, cost clerks, and shop foremen to a comprehensive understanding of shop conditions. Reference to the chart gave the men in the receiving department information as to where various classes of material were to be sent. Similarly, each shop foreman saw that the parts and groups were not to pass to or from his department indiscriminately, but that there were fixed paths to be followed implicitly. The finished stock room was the clearing-house to which all parts or groups came and from which they issued in proper sequence. This method of procedure made it easy to inspect individual parts and facilitated control over the flow of material. It prevented the disorder incident to using the shop floor as a store room.

Charting Responsibilities of Department Heads

The charts illustrating general organization, which have been heretofore described, make no reference to officials or departmental heads by name. In preparing an ideal or ultimate organization chart for an existing or new business, it is always desirable, first, to chart the existing organization in this personal manner. It will nearly always be found that in an existing organization the personal element has played an important part. The organization has frequently had to adapt itself to the personal strength or weakness, specialized knowledge, or versatility of various individuals. When we consider that the corporation as a permanent institution is likely to outlive the various existing officials, it is quite apparent that it is desirable to make the chart of the organization as nearly ideal as possible. It frequently happens, however, that the realization of this ideal chart must be deferred for some years. In the meanwhile it is important that various officials and department heads, as well as minor employes in the various departments, understand exactly where they stand and to whom they are responsible. Hence, it is highly important to have an organization chart showing the relationships of departments to each other and the lines of responsibility and authority of the various officials.

Figure 9 illustrates a chart of this type. It refers to the same establishment as the one shown in Figure 8, and the figures designating the various departments, it will be noted, are the same in each chart. The name of each department head is given in each circle. Blue-print copies of this chart are distributed to the various department heads and posted on the various bulletin-boards in the shops and offices. While in some cases there may be

Fig. 9.—CHART

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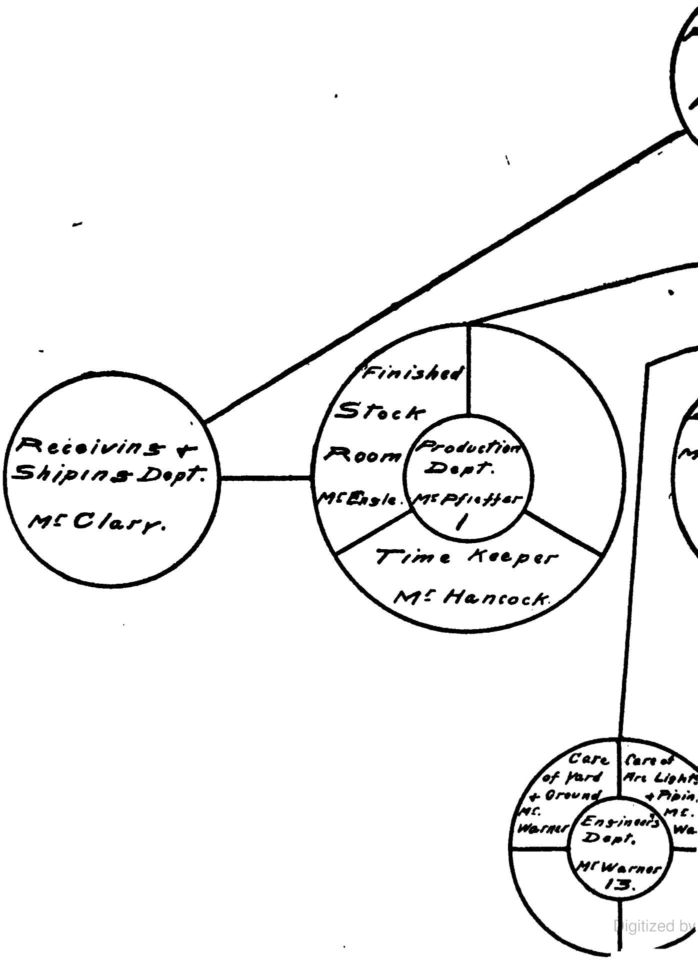

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good reasons for treating the ideal or ultimate organization chart as confidential information for the use of the company officers and general manager, there is every reason why a chart of the existing organization should receive the widest publicity among employes. Such publicity will prevent any misunderstandings and help employes towards getting a clearer understanding of the business as a whole.

TEST QUESTIONS

1. What are organization charts? How are they constructed?
2. Draw an organization chart showing the relationship and responsibilities of stockholders, directors, general manager, and department heads.
3. Draw a chart illustrating military line control without staff.
4. Draw a chart illustrating line-and-staff control.
5. Draw a chart illustrating functional control.
6. Draw a chart illustrating the sphere of action of shop committees.
7. What are some of the activities and statistics to be taken up by the manufacturing committee?
8. What are the duties of the tool committee?
9. What are the duties of the suggestion committee?
10. What are the duties of the safety committee?
11. What are the activities to be considered by the welfare committee?
12. What sort of questions are taken up by the educational committee?
13. What matters does the committee on designs of new products consider?
14. What sort of questions will be investigated by the committee on cost reduction?
15. What are the duties of the complaint committee?
16. Draw and explain a chart showing the principal sub-

divisions in the administrative, production, and selling divisions of some industry with which you are familiar.

17. What are the seven M's listed by Charles B. Going as the principal production factors?

18. Draw a chart showing the progress of an order from the sales department through the designing department and planning division of the shop.

19. What steps are taken by the designing department on the receipt of an order?

20. When a production order is issued, how is the provision of necessary materials taken care of?

CHAPTER III

LOCATING AN INDUSTRY

General Considerations

The factors that enter into the selection of a location for an industry concern themselves chiefly with the three production factors, materials, men, and markets, although a fourth, namely money, also plays an important part. When an industry is about to be started, or when through consolidation of smaller units into larger a combination has taken place, one of the most important questions confronting the management is that of where the industry is to be located so that from every viewpoint the site selected shall be the best. After the particular town in which the industry is to be located has been decided upon, there remains to be solved the no less important question as to what particular district or neighborhood in that town will be best.

So far as the selection of the general location is concerned, the following factors need consideration: (1) raw, semi-finished, and finished materials, supplies, and accessories essential to the business; (2) power required and available and its cost, whether water power or gas power is preferable to coal, or coal preferable to either of the others; (3) the effect of climate upon production; (4) transportation facilities; (5) the desirability of water transportation; (6) labor supply; (7) inducements in the

way of free land for buildings, cash bonuses, stock subscriptions; (8) money market; (9) sales markets; (10) nearness of other industries in the same or similar lines.

So far as the local site is concerned, after the general location has been selected, we have to deal with the following considerations: (1) space for expansion; (2) fixed charges due to high or low cost of land; (3) local labor market; (4) nearness of this local labor market to site; (5) local transportation facilities for freight and workmen; (6) fire prevention; (7) nearness to local trade centers. These various factors will now be considered in further detail.

Materials

If the materials required are but few and bulky, it is quite likely that nearness to supplies of cheap raw materials will be an important factor. Taking, for example, the iron and steel industries, we have to consider that pig iron is composed of approximately 28 per cent of coke, 16 per cent of limestone, and 56 per cent of iron ore. Some forty or fifty years ago central Pennsylvania was dotted with small furnaces, because limestone and iron ore were plentiful and hickory wood for coke abounded. As production centers rearranged themselves along the lines of the railroads, the cost of hauling from these country furnaces to railroad lines became an important factor and soon led to the concentration of the Pennsylvania iron and steel furnaces in certain railway centers convenient to the raw materials.

A new element appeared, however, in the Superior iron fields. Here the iron ore was so located that it could be handled by mechanical processes with a minimum of wage cost, since it could be conveniently dug with steam shovels and conveyed by machinery to the holds of vessels,

which in turn were unloaded by machinery. However, the Superior iron fields were remote from coal; hence, the furnace industry spread gradually toward the lake ports where the combined cost of coal, iron ore, and limestone showed a most favorable cost figure.

Where the raw materials are not so bulky, as for instance in the textile industries, nearness to raw materials is not so important. The New England States still lead in textile manufacturing, although the raw materials come from the South so far as concerns cotton, and from the West so far as concerns wool.

Where the materials supplied are numerous and of a semi-finished or finished nature, as is the case in an assembling business like the making of automobiles, requiring supplies of bar stock, bolts, nuts, washers, rods, etc., in great variety, as well as drop-forgings and castings purchased mostly from jobbing shops, the best market for raw materials will be a general metal-manufacturing territory. Here there will be competition in prices of the materials as well as avoidance of delays due to a scarcity of suppliers and inability to follow up purchase orders.

Again, taking the automobile business, after it has been settled that a metal-manufacturing territory is essential, the further consideration arises as to nearness to manufacturers of finished accessories such as radiators, magnetos, tires, etc. All of these considerations have led to a concentration of the automobile-manufacturing industries in a territory roughly indicated by a line connecting Buffalo, Cleveland, Indianapolis, Lansing, and Detroit.

Power

Power is an important factor in the steel, glass, brick, tile, pottery, iron, and forging lines of business. In the assembling ones it is less important. There are also cer-

tain metallurgical and electro-chemical industries which require a great proportion of power in their conduct. These considerations have resulted in the establishment of iron and forging enterprises in locations having cheap coal for power and recommended by nearness to raw materials. Such a combination is found in Pennsylvania, Ohio, and parts of Indiana, Illinois, and New York. A combination of clay and cheap gas fuel such as is required for the ceramic industries is found in the gas fields of West Virginia and Ohio. The abundant water power in the vicinity of Minneapolis accounts for the establishment of flour mills which are also near to the market for raw material. Similarly, cheap power combined with cleanliness has led to the establishment of the carborundum works and shredded-wheat factories at Niagara Falls.

Climate

Prior to the perfection of mechanical methods of humidifying, dehumidifying, heating, and cooling local bodies of air in factories, warehouses, kilns, etc., the natural climate played an important part in the selection of sites for certain factories such as cotton mills, silk mills, cigar factories, etc. On account of the ability of manufacturers to produce artificially almost any desired climatic condition in the factory, climate is less important at the present time for the foregoing considerations than for its influence on the comfort and healthfulness of the workers in their homes and life outside of the industry.

Transportation Facilities

Where the raw materials and finished product are bulky and heavy, the cost of transportation is an important factor. Where the materials and product are light, the prob-

lem is less important from the standpoint of first cost of production, but it is equally important from considerations of adequacy of service.

From considerations of transportation costs, that location is most advantageous which minimizes the combination costs of freight and express on incoming materials and on outgoing finished goods. In the furniture-manufacturing industry, for example, a factory located close to the source of lumber supply might have any advantage due to closeness to raw materials offset by the high freight on finished product and by the inability to make quick deliveries of finished product owing to its remoteness from sales markets.

Convenience to various fields of raw materials and to markets is afforded by selecting a site where railways converge. This is particularly true when the railways are long, important lines. Examples of such centers are found in Kansas City and Indianapolis.

Adequacy of service is assured where there is competition between transportation companies. Rebates and other forms of rate-cutting are not to be considered as a fruit of competition, but the securing of commodity rates and prompt car service as well as prompt attention to tracers are all advantages resulting from rivalry in transportation service.

Water transportation is advantageous wherever it connects the plant with important sources of raw material or good sales markets. It by no means follows that it is a weighty factor merely in those industries using large bulky materials which are not injured by water. Lumber, iron ore, coal, and oil are certainly important items in the list of articles carried by water-transportation companies, but an inspection of the docks and wharves at any of the inland ports where railroads and water-

ways converge will reveal the miscellaneous nature of the goods shipped by water, and show that much in the way of finished goods is carried by boat.

Certain inland cities afford excellent competition between land and water transportation as well as a wide field for operation between the factory on the one hand and raw materials, supplies, and sales markets on the other. Such cities usually can also furnish at low cost an adequate water supply for power and manufacturing purposes and they have abundant water for fire-department use. Among cities of this class we may mention, for example, Pittsburgh, Cincinnati, and St. Louis as possessing the advantages of rivers and railroads. Buffalo, Erie, Cleveland, Detroit, and Milwaukee are recommended by the competition of lake and rail routes. Boston, Providence, New York, Philadelphia, Savannah, New Orleans, Galveston, and San Francisco are examples of cities having coastwise shipping routes along with railways, being at the same time convenient for foreign export or import.

Labor Supply

An industry requiring a large number of unskilled laborers is preferably located near a source of that kind of labor. The tendency of immigration from southern and eastern Europe has been to follow certain lines of distribution. Pittsburgh and Chicago are important points on these lines and hence afford good markets for a supply of this class of labor. Certain sections of the country have developed centers of population where an almost hereditary liking for the trades requiring a medium degree of skill is found. In the Connecticut River valley there is an abundance of labor proficient in operating automatic metal-working machinery. In the Cincinnati

territory machinists are plentiful. In Pennsylvania steel and furnace workers in general are easily found. Industries requiring large numbers of highly skilled operators, such for instance as engraving and lithographing establishments, usually find large centers of population the best source of supply for highly skilled labor.

Special Inducements Offered

A growing industrial center will frequently offer desirable inducements to industries in search of a location. These inducements may take the form of free sites for buildings, cash bonuses, stock subscriptions, or a combination of all of these. Free land alone is not an inducement unless the land is well located, is subject to low tax rates, and affords opportunity for expansion. Moreover, the town in question must be of some strategic value when all of the other factors already discussed are taken into consideration. Cash bonuses are less frequent, but their equivalent may take the form of buildings and sites reverting to the donors in case the industry fails to keep its part of the agreement, which is usually that employment is to be given to a specified minimum number of men. Cash bonuses are sometimes raised by a sale of lots adjacent to the land given the new enterprise. Stock subscriptions are often desirable in order to secure the co-operation of local investors in the enterprise.

All of these inducements must be considered as secondary to the primary advantages of best natural location. At the same time these inducements, coupled with natural advantages, may make it possible to start a thriving industry which could originate in no other way, or they may enable an industry which is handicapped by lack of room or other factors to find just the right place for growth and expansion.

Money Market

Any thriving industry depends very largely on local or near-by banks for occasional advances of money on the securities it has to offer. A business wishing to realize the greatest possible earnings from its capitalization can afford to maintain only a small percentage of that capitalization in the form of bank balances, since such bank balances do not pay any profits. Yet it often happens that large purchases and large pay-rolls must be provided for before the receipts from the sales of increased outputs are available. Under these conditions it is important that local banking facilities be such that the business can be put on an equal footing with similar ones in other localities. These considerations point to the need of investigating the local money market as an important factor in determining the location of the proposed plant.

Sales Markets

A large number of important industries made their start in the best sales market. After the business was thoroughly developed and a strong sales department organized, they could afford to select a new location. Under such conditions the old site could be used as a branch factory. Places where buyers congregate afford natural advantages for a business just starting.

Taking the furniture-manufacturing business, for example, we find that buyers congregate at Grand Rapids in the summer and winter at predetermined dates to inspect new styles. Permanent furniture expositions are also conducted in Chicago, New York, St. Louis, and San Francisco. A new furniture business might well consider carefully the advantages due to nearness to that

one of these markets in which it proposes to conduct its strongest selling campaign.

Nearness to other establishments in similar lines is also often of advantage. Buyers from various parts of the world come to Cincinnati to inspect machine tools. Numerous small concerns building specialties in the machine-tool line have as a consequence found it advantageous to start in Cincinnati.

Local Site

Having determined on the particular town in which the industry is to be located, the selection of the local site is one of equally great importance. There must be room for expansion, and at the same time the fixed charges due to interest on the investment in land and taxes must not be too high.

Local Labor Market

A fluctuating force of employes is always a severe handicap. A location which attracts permanent workers rather than "floaters" is to be sought. Most employes do not like long rides on street cars or on commuters' trains. Hence, a location near the homes of people who would form the working force of the business is desirable. Nearness to the working-men's homes makes it easier to develop athletic and social activities fostering the personal relationship and personal interest in the business.

Local Transportation Facilities

If the factory is to be a place to which prospective customers are to be brought, the question of local transportation service is important. There is always also a considerable proportion of the employes who will have to

be drawn from localities other than the immediate neighborhood of the plant or the area within walking distance. Hence, good street-car or accommodation train service is necessary.

From the viewpoint of greatest advantage in freight transportation, it is desirable to be located at the intersection of several railroads or on a belt-line, and in a locality where teaming or auto-truck service to other depots is not a heavy expense charge.

Nearness to Local Trade Centers

If the industry is of an assembling nature requiring the purchase of small items of raw material, or purchased finished parts on short notice, then it is important that the site be near local sources of supply of such items, as remoteness would cause delays.

Fire Prevention, Water Supply, and Sanitation

A suburban site is frequently remote from good fire-department apparatus, and the cost of installing and maintaining a fire-prevention system must be considered. Similarly, adequacy of water-pipe lines and sewers and cost of installing private lines need consideration.

Industrial Surveys

In order to aid business men contemplating location in a given industrial center, we frequently find boards of trade, commercial clubs, or municipal commissions employing expert industrial engineers to prepare what have been designated as "industrial surveys." Such surveys report on the nature of the leading industries in the locality in question, the number of persons employed, amount of money invested, bulk and value of output, to what points the output is shipped, advantages

of the town or city in question as regards some or all of the foregoing considerations discussed in this chapter. Such surveys are also used to set forth opportunities for certain lines of industry which appear to exist according to the opinions of the persons making the survey. Industrial surveys are taking the place of haphazard solicitation of new industries. They afford just the data needed by the directors of industries seeking a new location.

Incidentally, industrial surveys serve another very useful purpose, namely, that of helping bureaus for vocational guidance in connection with public-school systems or private social efforts, and assisting young people to get a view of the local field of employment.

TEST QUESTIONS

1. What are the principal factors that enter into the selection of a certain town as a desirable location for an industry?
2. When the town is decided upon, what considerations affect the selection of the local site?
3. Under what conditions is nearness to raw materials desirable?
4. In what classes of business is power an important factor?
5. Discuss the influence of climate on the selection of factory location.
6. How may we secure good transportation service?
7. Under what conditions is water transportation advantageous?
8. How does the question of labor supply affect factory location?
9. How may a progressive young town in a favorable industrial location finance the offering of free factory sites including bonuses, buildings, or stock subscriptions?

10. How may railroads and navigation companies assist industries as well as towns along their systems in the way of factory location?

11. How do local financial conditions affect the selection of a town for a factory location?

12. Under what conditions is it desirable to locate in or close to the sales market?

13. How does local labor supply affect the selection of a factory site in a given city?

14. How does the question of local transportation facilities affect the selection of a factory site in a given city?

15. How does nearness to local trade centers influence the selection of a factory site?

16. What influence do questions relating to fire prevention, water supply, and sewage, have on the selection of a local site?

17. What is an industrial survey?

18. How can an industrial survey be made useful in connection with educational policies?

19. How can an industrial survey be made of use to local industries?

20. What sort of educational training and experience would you consider necessary for a person who is to act as industrial agent or adviser in questions of factory location?

CHAPTER IV

MANUFACTURING PLANTS AND EQUIPMENT

Importance of Arrangement and Equipment

Many successful industries had their beginnings in rented quarters or in small buildings not planned with any particular reference to production. As these industries grew and a careful analysis was made of costs of production, it became evident that the influence of the arrangement of buildings, departments, and equipment on costs of production was very important. The realization of the economic importance of these factors has led successful manufacturers to considerable expenditures in money and time in making careful lay-outs of industrial plants for the purpose of starting a new one, for making extensions, or looking to removal from an old site to a new one.

This same recognition of the importance of the problems involved has led to the rise of a class of industrial engineers, some of them acting as designers, others as designers and contractors, who make a specialty of the lay-out, design, equipment, and sometimes the initial operation of industrial plants.

Principal Factors to be Considered in Plant Lay-out

The controlling influences in arranging and designing industrial plants are (1) processes and (2) service.

Under the heading of processes we shall have to consider (a) the general process-mapping of the industry; (b) the routing of the separate classes of material or parts through the establishment as a whole and through each distinct department; (c) machinery and fixtures involved in industrial processes; (d) departmental arrangement by processes.

Under the heading of service we shall have to consider the following: (a) power; (b) heat; (c) ventilation; (d) light; (e) sanitation; (f) transportation; (g) storage of (1) raw materials, (2) work in process, (3) finished individual parts, (4) assembled groups, and (5) completely finished product; (h) receiving and shipping; (i) tool rooms; (j) wash rooms; (k) foremen's offices; (l) spaces for planning department, bulletin boards, time clocks, cost and stores records, etc.; (m) inspectors' quarters; (n) fire-prevention, safety, and welfare arrangements; (o) drafting and designing space; (j) commercial, administrative, and supervisional officials' offices.

Process-Mapping

Process-mapping consists of the charting of the general processes involved in the industry. Naturally, analytic manufacturing would present a different type of process-mapping from that of synthetic manufacturing. Similarly, an industry employing consecutive processes would present an entirely different process-mapping from that of an industry in which simultaneous processes are the rule. For instance, a linseed-oil factory is an extractive or analytic industry and would require an entirely different process-map from the one needed by a cement mill, which is a synthetic industry. Again, a rail mill is a continuous process and requires entirely differ-

ent process-maps from those of a sewing-machine factory, which typifies simultaneous processes followed by assembling.

Preliminary general process-maps can be made for a given industry by listing first the general operations. If these are all consecutive, we shall have the list in one

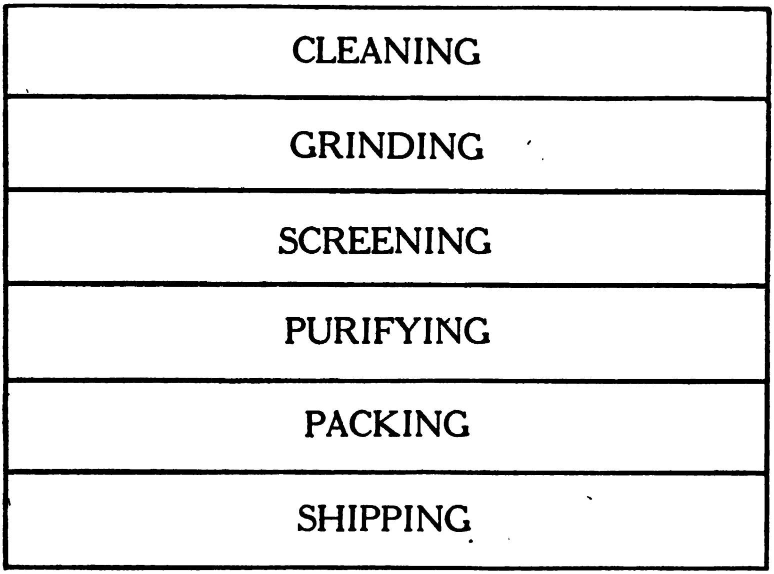


FIG. 10.—Lay-out of a Flour Mill, Illustrating an Analytic Industry with Consecutive Processes, Located in a Single Multifloor Building

column. If some are simultaneous, they will be in several columns. Then we can decide definitely, from our knowledge of the processes, which of them require separate buildings and which can be housed together, also which processes must be on the ground floor and which may be on upper floors. For example, it is easy to decide that painting agricultural machinery by the dipping process

should be in a separate building from the machine work on the metal parts, and that assembling large boilers must be done on the ground floor.

We can now roughly sketch a phantom-perspective view of a building or group of buildings devoted to processing, for the present omitting power-plant and all service

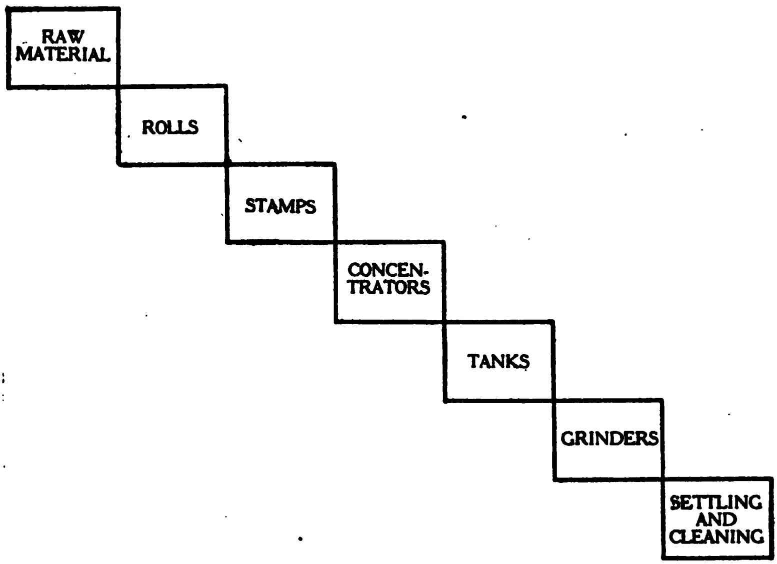


FIG. 11.—Lay-out of an Ore Mill, Illustrating an Analytic Industry with Consecutive Processes, Located on a Hillside to Take Advantage of Gravity

equipment. We may indicate in colored crayons or colored inks the various principal processes and the paths for the flow of materials, supplies, and work in process, as well as by-products and waste, if any. Figures 10, 11, 12, and 13 are simple forms of preliminary process-maps.

Routing Individual Parts or Classes of Material

Routing is different from process-mapping in that it traces the path of a single part. For instance, in making a process-map for an automobile factory, we have before us an entirely different task from that required if we

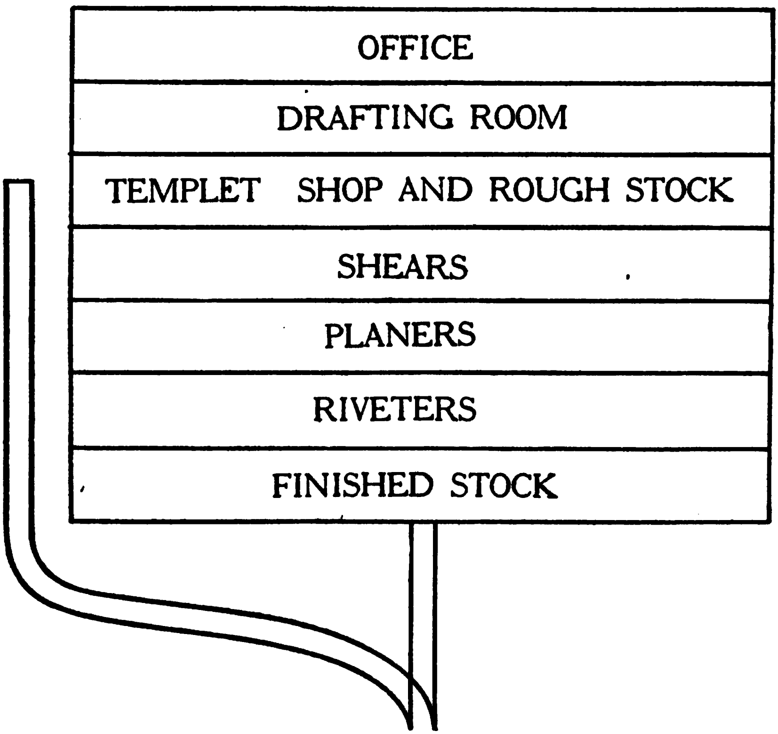


Fig. 12.—Lay-out of a Structural Steel Plant, Illustrating a Consecutive-Process Synthetic Industry

route a crank case to be made in that same factory. To route the crank case, we inspect the blue-print and list the separate operations to be done. Process-mapping is a generalized survey of the whole industry. Routing

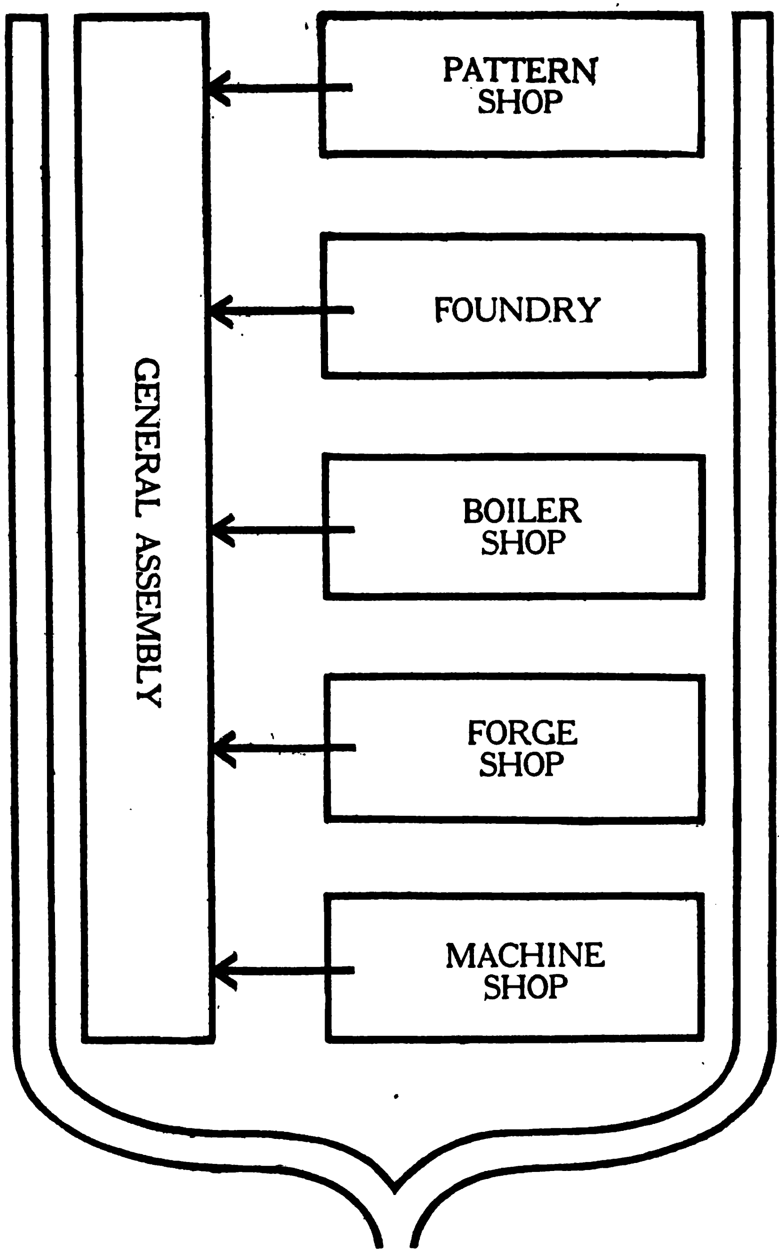


Fig. 13.—Lay-out of a Locomotive Shop, Illustrating a Synthetic Industry with Simultaneous Processes, Followed by General Assembly

is a detailed investigation which, when thoroughly built up, may materially modify preliminary process-mapping. A well-organized system of routing and a good stock of routing records covering the product form the very best basis for an intelligent process-map. Of course, in starting an entirely new industry the experience and judgment of the men in charge of the productive end of the

Part BOX - BACK Size { Pl. 1 / Un. 1 1-1/2 } Card No. 269

OPERATION	SYMBOL	Mins. each	REMARKS
1 Bore & Turn (Outs. & ins.)	B & T	21.6	
2 Keyway for babbitt	K1	17	
3 Babbitt	B40	30	
4 Bore (Roll babbitt & Oilgroove)	B	23.5	
5 Turn	T	35	

Fig. 14.—Typical Routing Card Giving Operations to be Performed on Each Piece

Mnemonic symbols for operations are generally used on all shop tags and cost cards, thus saving time and space.

enterprise form the only basis for process-mapping. Figure 14 is a typical routing card giving the operations to be performed on an individual part.

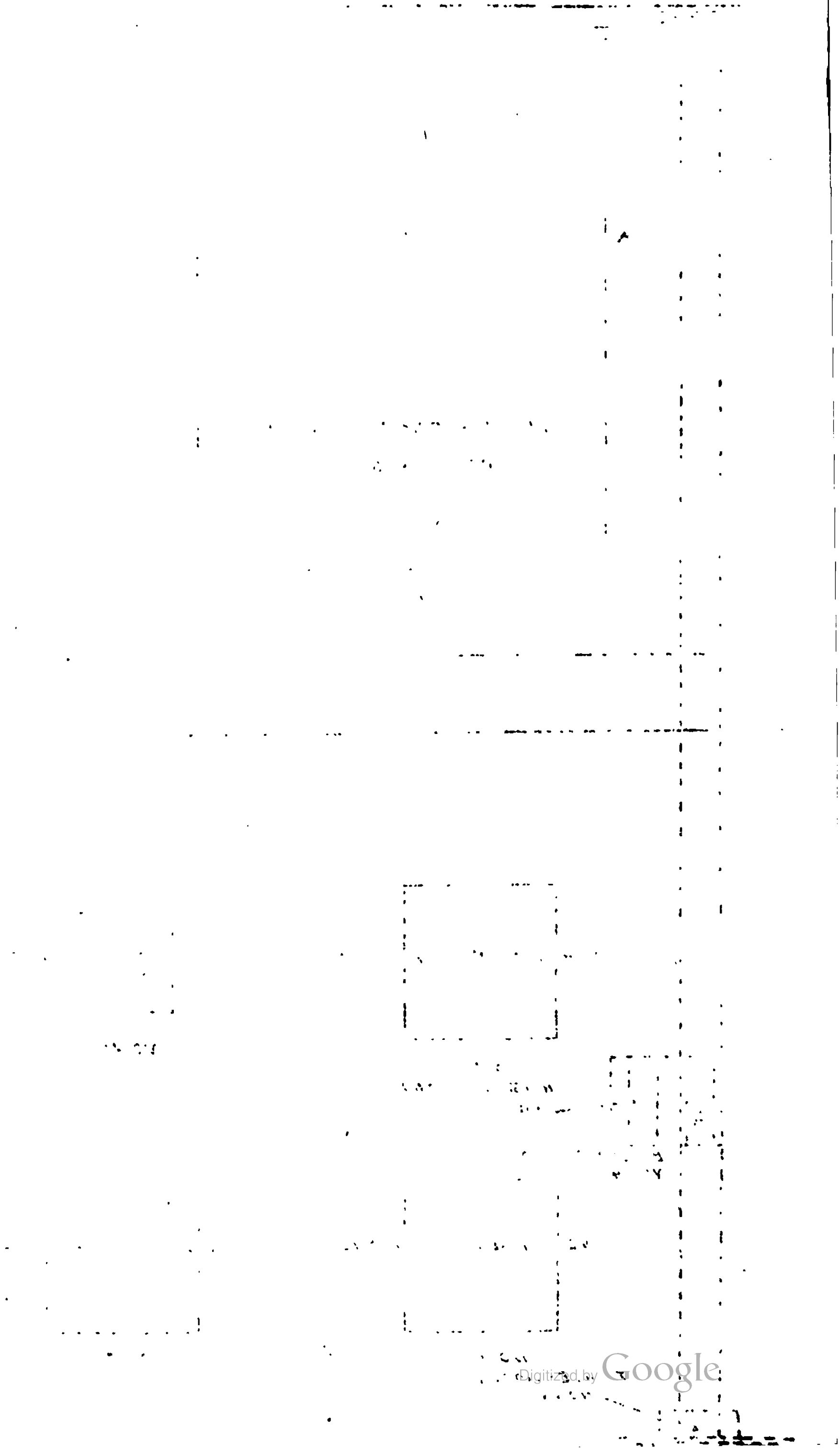
Selection and Arrangement of Machinery and Fixtures

After having laid out the preliminary general process-map, it is desirable to take a large sheet of drawing-

paper for each separate department and indicate roughly the most prevalent routes of material, parts in process, and supplies, by-products, and waste through this department. Knowing the capacity of output, we must next determine how many units of processing machinery or devices are to be placed in the department, and of what capacity each must be. We are going on the assumption now that we have not restricted the confines of the department by any room or building walls, but are going to make the building and rooms suit the processes. We can be guided by the number of units and capacity of processing machinery and devices for a given quantity of output used in similar establishments elsewhere, if such data are available. If they are not, it becomes necessary to estimate the time required for processing each part and for providing the necessary number of units of processing machinery to furnish the output wanted in a given time.

We next investigate the floor area required by each processing machine or device and its dimensions together with space required around it for operators and storage. We must also allow room for free transportation by truck, wheelbarrow, industrial railway, or crane, as well as room for expansion by the placing of an additional processing unit in the future in the most desirable location, provided there is any likelihood of such expansion, any floor space available, and the allowance of such space does not increase cost of production.

In arranging the various machines and fixtures, it is very convenient to cut out forms or templets to scale so as to represent the floor space occupied by the various machines and fixtures. The name of the equipment and horse-power required, together with dimensions, should be written on the templet. These templets are then ar-



ranged and re-arranged until the most satisfactory collocation in the department has been reached, whereupon they are fastened with tacks to the paper or board representing the department. Figure 15 is an example of a plant lay-out arrived at by use of templets as indicated.

Departmental Arrangement by Processes

The foregoing investigation will give sufficient information on which to base approximate dimensions for the leading processing departments. It is desirable to have data available from similar establishments giving the square feet per department per unit of output and per employe. Such data are useful for comparison. We now are in a position to cut out templets on a smaller scale than the large sheets representing departments, a templet for each department, and can arrange the departments in most advantageous relation to each other so far as processing is concerned. Before deciding anything definite, however, we have next to consider the space and location requirements of the service equipment and service departments.

Power-Generation and Transmitting-Apparatus

It has already been suggested that the horse-power should be listed on each templet representing processing machinery. We cannot designate the motor required for each department nor the power required for the plant as a whole until we have investigated certain other power-consuming service apparatus connected with heat, ventilation, light, and transportation. It is therefore the last item to be considered.

Heating, Ventilating, Humidifying, and Air-Washing Apparatus

This part of the plant is entirely too important as an economic factor in production to be left to an inexperienced architect or to a local pipe-fitting contractor. Unless there is experienced engineering skill available among the employes of the establishment, this matter as well as the entire question of factory specifications should be left to an experienced industrial engineer. However, it is necessary for everyone connected with shop management in any form to appreciate the importance of the principles involved. For this reason the discussion has been introduced here.

Direct radiation arises from the running of pipes containing steam or hot water into the rooms and spaces to be heated, and running these pipes either overhead, along the walls, or fastening them to radiators. Where direct radiation is used in factories there should be a system of controlling the circulation of the steam and condensed water by other means than gravity, as the long distances involved usually interfere with the success of the gravity return system. Direct radiation is preferred by many shop-owners to a hot-blast system, because it costs a little more to heat the air and blow it through the establishment than it costs to install direct radiation. However, where direct radiation is used, it should be accompanied by a suction foul-air exhaust system arranged to remove the vitiated air at a proper rate. Such a system consists of ventilating flues in the walls connected with a central flue, at the top of which is a suction fan of required capacity.

Advantages of Hot-Blast System

The hot-blast system has advantages from a hygienic standpoint that make it well worth the slight additional cost over that of the direct radiation system. There is always plenty of fresh air, if the supply of air to be warmed is pure. This air, on being forced out from the hot-air flue, penetrates in all directions and is better circulated than the air heated by direct radiation, even with the aid of foul-air ducts and an exhaust fan. The ventilating ducts and exhaust fan are also used in connection with the hot-blast system.

The greatest advantage of the hot-blast system, however, and one appreciated only within recent years, lies in the fact that we can by it control not only the temperature of the air supplied, but also its humidity. The lassitude of workers confined in buildings has been found to be largely due to the dryness of the air. This same dryness makes us demand a higher temperature. Air at proper humidity and at a temperature of 63° Fahrenheit is as comfortable as dry air at 70°. Hence, we can save coal in our heating-plant and insure freedom from colds and from catarrhal and grippe troubles by humidifying our air. Humidifying apparatus is now sold by the manufacturers of all mechanical heating appliances and is becoming so generally used that no progressive industrial establishment can afford to be without it, as it is a most important economic factor in bettering the health of employes and thus securing greater contentment and bigger output.

So far as department lay-out is concerned, the only way in which the heating and ventilating apparatus enters is in the matter of locating radiators and registers or ducts. These locations should be indicated in their

preferred positions, so that these may be conformed to as near as possible in the installation.

LIGHT

Provision should be made for abundant daylight. The use of metal sash enables us to make the window frame of strong, light material. Where the light must penetrate more than twenty or twenty-five feet into floors having a height of only ten or twelve feet, it is desirable to introduce prismatic-glass panes into the upper sections of the window sash. Where multifloor construction is used with widths of floors of more than sixty feet it may be necessary to introduce artificial lighting in the daytime. The tendency is all in favor of the reflected light or "full indirect" type of chandelier presenting an opaque surface to the eye and reflecting the light to a diffusing ceiling.

Ordinary illumination for rough work demands an intensity of light of not less than one foot-candle, which means that the light is the same as would be given on a sheet of paper a foot distant from a standard candle. For reading purposes, an intensity of two foot-candles is required, and for accurate machine work three foot-candles are requisite.

The spacing of the lights and their height from the floor and below the reflecting ceiling must be determined by calculation. In single-floor buildings more than fifty feet wide the saw-tooth roof with northerly exposure gives us good daylight illumination. However, unless level reflecting surfaces are provided, the full indirect reflecting system cannot be used with a saw-tooth roof, and a translucent glass is used under the chandelier instead of a reflecting opaque type. This is known as the "semi-indirect system." The drop cord with unpro-

tected glaring filament is absolutely obsolete so far as intelligent illumination is concerned. It is a source of eye-strain and fatigue which materially interferes with efficiency of production.

Wash and Locker Rooms

It would be better if these rooms were distributed about the plant instead of being concentrated in one location. Such distribution saves the time of employes who are compelled to use them during working hours. Departmental arrangement must provide for such rooms in convenient locations.

Transportation

We must allow room for the easy passage of trucks as well as a storage room for trucks not in use. We must also provide for modern elevating trucks loaded with material. If the storage-battery type of motor-driven trucks is to be used, provision must be made for their storage and maintenance. If industrial railways are to be used, space must be allowed for tracks and turn-tables. Room must also be allowed for trolley systems, hoists, and overhead cranes, if it is found that they are requisite.

Store Rooms

Storage of raw materials, work in process, finished individual parts, assembled groups, and completely finished product must be provided for by allowing space for such storage wherever needed. The store rooms require proper equipment in the way of bins, racks, shelves, etc., to insure ready accessibility as well as safety against damage and theft. The working part of the shop should not be interfered with by any attempt to combine storeroom functions with processing activities.

Receiving and Shipping

The receiving department may be under the same jurisdiction as the purchasing and stores, or under the shipping department. In any event its location is likely to be most favorably determined when we consider its own functions irrespective of what other department it may be under, so far as jurisdiction is concerned. If most of the small materials are received by team or express, it may be desirable to have it located where such teams can most conveniently arrive, unload, turn around, and depart. Both receiving and shipping must be convenient to the store rooms. Receiving will probably have to be nearer the raw-material stores, and shipping will have to be nearer the finished-product stores. In case carload receipts and shipments are only occasional and there is but one track, this track will have to be accessible to both receiving and shipping departments and a clear passageway to it from both of these departments will have to be provided. If coal and ashes in carload lots constitute a considerable factor, these items will also have to be considered in laying out the trackage.

Tool Rooms

Tool-making and tool-storage are distinct functions and must not be confused. Tool storage and delivery may require a messenger-boy service, a pneumatic-tube service, a cable-driven basket service, or a dumb-waiter service, as well as supplementary storage and delivery rooms.

Foremen's Offices

Where the foreman is a working gang boss he will probably not need any desk room. However, there are industries which, even when provided with a planning

department, require that certain foremen may have privacy for studying blue-prints and specifications and for interviews. The clerical help of foremen must always be kept at a minimum. Where a private office for a foreman is in the interests of efficiency, it must be provided for and space allowed for it.

Planning-Department Fixtures

A planning department usually requires the allowance of room for bulletin boards on which are listed the jobs to be worked on by each man in a department or sub-department. This means that the floor around this bulletin board must be kept clear and preferably fenced off by pipe.

Inspectors' Quarters

Space will have to be allowed for inspectors as well as for benches and appliances, accommodating as much work in process as is likely to accumulate in such space. In some establishments inspection takes place only prior to turning a piece into the stock room for finished parts. Under such conditions only one space is required for inspectors. In other establishments inspection takes place at more frequent intervals and in various parts of the shop; in such cases the inspectors' quarters must be located so as to cause least delay in the progress of materials.

Fire-Prevention, Safety, and Welfare Arrangements

The location of hose attachments, hose, chemical extinguishers, fire escapes, belt guards, and any other safety devices taking up space, will have to be taken into consideration. Among welfare arrangements those re-

quiring space are such as hospitals, rest rooms, physician's office, lunch rooms, library, and assembly room.

Drafting and Designing Space

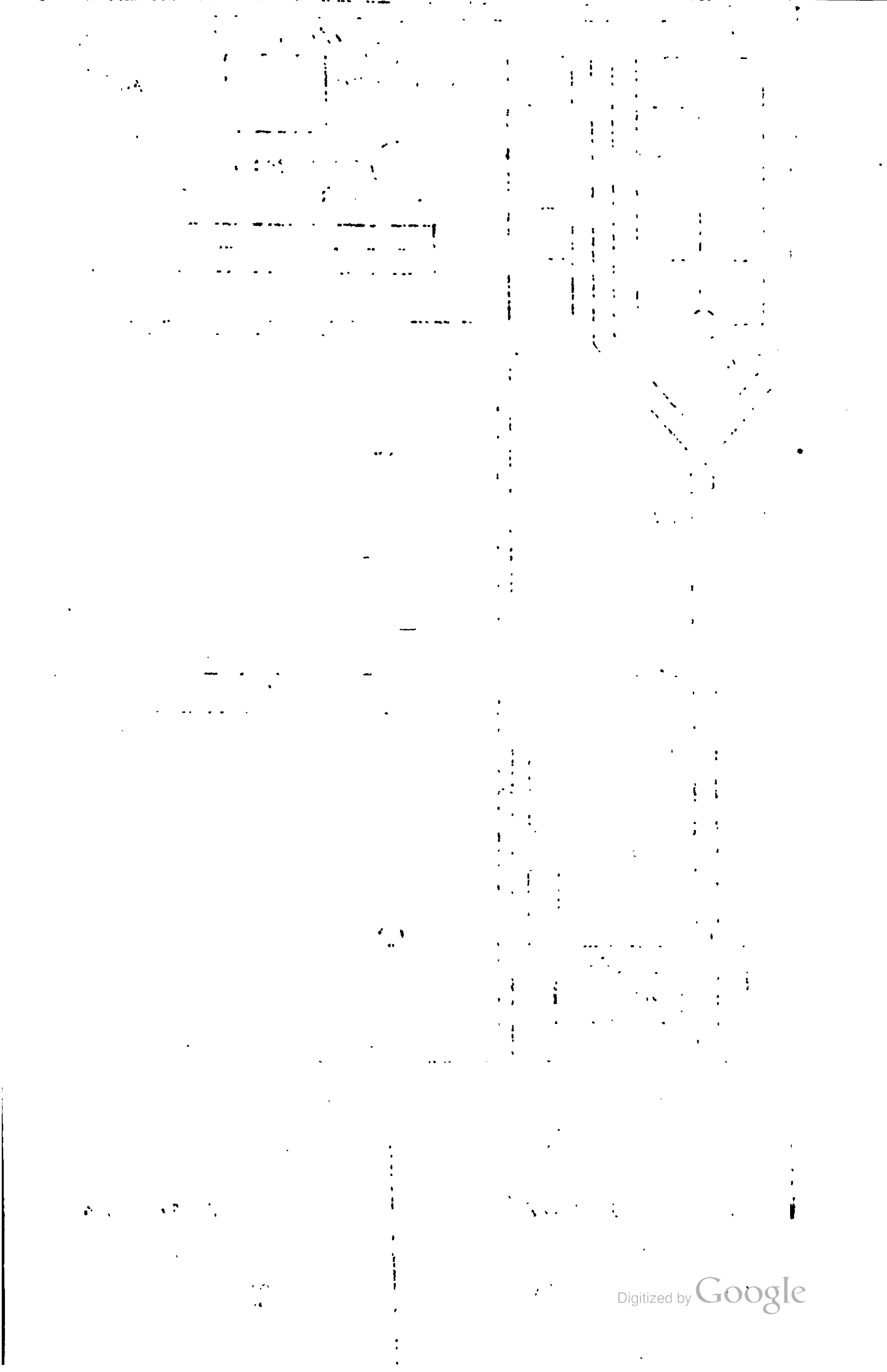
The drafting and designing space must be located where it has the advantage of good daylight, and as nearly as possible situated at an equal distance from the commercial and sales offices, the main planning-department office, the pattern and drafting department, and the main inspection office. The resulting location is usually something of a compromise.

Commercial Offices

The commercial offices used for administrative and supervisional officers should be arranged in such a manner that visitors to the purchasing department, accounting department, applicants for positions, and prospective customers can be directed into separate waiting rooms. The internal arrangement of the commercial offices should be made the subject of as careful a lay-out as the arrangement of the factory equipment and productive departments.

Final Arrangement

After having indicated on the preliminary separate departmental sheets, and also on a large preliminary general lay-out, the location of all the service equipment and service departments, we are now ready to make the final lay-out. This lay-out can be visualized more completely by means of a wooden model built to the scale of the proposed factory buildings, but showing the side walls in framing only and having the floors solid. On the floors are fastened (with pins) templets showing the various equipments, departmental boundaries being indi-



cated by painted lines. The principal paths of progress of material, as determined by the preliminary process-mapping, are indicated by the use of threads of various colors. Figure 16 shows the ground-floor plan for a gas-engine manufacturing plant, which has been arrived at by cutting out templets representing various departments and arranging them until the most satisfactory collocation has been secured.

TEST QUESTIONS

1. What four groups of considerations are involved in studying processes as related to plant lay-out?
2. What features are to be considered under the heading of service?
3. What is process-mapping?
4. Make a graphical process-map for some simple industry with which you are familiar.
5. What is routing, and how does it differ from process-mapping?
6. What considerations enter into the arrangement of surrounding floor space for process machinery and fixtures in a given department?
7. Of what use are paper templets of machines and fixtures in making a department lay-out?
8. What comparative statistical data are desirable in determining the area of various departments?
9. How may paper templets be used in determining departmental arrangement?
10. What arrangements should be made for controlling the circulation of steam in radiators and for the removal of foul air when a direct radiation heating system is used in a factory?
11. What are the advantages of a plenum hot-blast system?
12. What arrangements should be made for abundant daylight illumination?

13. What is meant by a foot-candle of illumination?

14. What intensity of artificial illumination is required for reading purposes? For accurate machine work?

15. Discuss the injurious effects of glare and state how they may be avoided.

16. What considerations are involved in the design of wash and locker rooms, store rooms, and tool rooms?

17. What provision must be made for transportation of various sorts?

18. What considerations are involved in locating receiving and shipping department, foremen's offices, inspectors' quarters?

19. What considerations are involved in locating fire-prevention and safety apparatus, drafting and designing space, and commercial and administrative offices?

20. How may the final arrangement be visualized in the most striking manner?

CHAPTER V

BUYING

Qualifications of a Purchasing Agent

The purchasing agent's activities involve almost all of the production factors enumerated. He has, of course, to deal primarily with materials and the markets for these materials. In his contact with salesmen and suppliers of materials he must deal with men. In knowing his financial limits he has to deal with money. In devising good systems and running his department economically he has to do with methods. It is quite apparent, therefore, that he must be a versatile, broad-gage man. He is probably the most important official next to the general manager and works manager.

It is important that an assistant or substitute for the purchasing agent be under training in every well-organized business. While such an assistant may not, before he has had sufficient training or experience, be ready to take the purchasing agent's position in case of a sudden vacancy, he can tide over the intervening period between the old department head's time of leaving and the time required for the new purchasing agent to become acquainted with the business. In a great many instances, if the assistant has had sufficient training and experience and is mature enough, he can be appointed to be the head of the department in case of a vacancy.

Knowledge of the Materials

Although the purchasing agent is not expected to possess the scientific accuracy with regard to the technology of a business that must characterize the chief chemist, chief engineer, or designer, he must have or acquire a knowledge of the industry and its processes, so that he can discriminate intelligently in all questions relating to the materials and supplies he is called on to buy.

Data Regarding Materials

The purchasing department should maintain a bureau of information covering the sources of supply of all materials and supplies of the business. Such information is contained not only in catalogues of suppliers, but also in text-books, periodicals, and clippings relating to these subjects, as well as in statistical data covering past purchases, the source of these purchases, the quantity bought, and prices paid. The above information is best kept in document cases or in some of the various proprietary styles of filing cases designed to hold catalogues, circulars, leaflets, and sheets. A uniform style of container is advisable. A mnemonic system of classification is recommended.

A mnemonic system is one in which certain classes of subjects are designated by abbreviations selected so as to give a hint of the word and yet different enough from one another not to be confusing. As an alternative method a system like the Dewey Library system is commended, in which a certain number stands for a certain subject, decimals signifying sub-classifications. For instance, in a mnemonic system we might indicate vertical water-tube boilers by the symbol BVWT, and all catalogues, specifications, data, etc., regarding vertical water-tube boilers

would be found in that section of filing boxes in which the boxes were marked with the symbol BVWT, each individual catalogue, circular, or sheet being marked in the same manner. We should then have two alphabetical finding indexes, one set arranged by names of materials and articles, the other being arranged by names of firms or authors.

SUBJECT Water-Tube Boilers(Vertical)		
SYMBOL: B V W T		
NAME	ADDRESS	CAT.
Wickes Bros.	Saginaw, Mich.	Wil

FIG. 17.—Index for Information and Catalogue File in Purchasing Department

Knowing the subject, one can locate the catalogue, pamphlet, or book by means of this index.

Figure 17 shows the card for materials in the finding index, and Figure 18 the card for names of firms or authors of papers, pamphlets, or books.

The method of filing as above outlined is much better than another frequently used, according to which catalogues are filed, either consecutively or by sizes, as they are received, being designated by consecutive numbers

indiscriminately. It is true that the index cards under such a system will serve to locate the catalogues and pamphlets. The method illustrated has the advantage of keeping together all material pertaining to a given subject. The mnemonic system or the Dewey decimal system with abbreviations after the decimals to indicate the name of the author or firm, admits of flexibility in that

NAME Wickes Bros.		
ADDRESS Saginaw, Mich	SYMBOL	CAT.
ARTICLES Water Tube Boilers (Vertical)	B V W T	Wi 1

Fig. 18.—Index by Names of Firms or Authors for Purchasing Department's Information and Catalogue File

Knowing the name of the firm or author, one can locate the catalogue, pamphlet, or book by referring to this index.

the space allotted to any subject may be enlarged as the number of catalogues or papers pertaining to that subject increases. The tests of a good filing system are flexibility, expansibility, and ease of finding the desired information.

Knowledge of Markets

There are two distinct policies observed in connection with buying. One limits the purchasing agent's activities to the buying of materials at such times and in such

quantities as requisitions from the departments authorized by the works manager to make requisitions may specify. The other policy encourages the purchasing agent to study the markets with a view to buying when prices are low.

The first policy contends that to buy when the market is low is taking the purchasing function into the field of speculation. Where production is variable and difficult to determine approximately in advance from the basis afforded by a comparison of past statistics with estimates of the future, the first policy is usually necessary.

Where records of former purchases and data regarding orders in hand and probable production of the next six months or a year form a reliable basis as to estimates of material required for this period, the second policy of encouraging buying when the market is low is frequently adopted. This policy, when it involves outright purchase in advance of requirements, means that money must be available in the form of cash on hand or borrowing ability to provide for the stocking up, and there must be as well storage room for stores of materials thus bought in advance.

A compromise policy is sometimes feasible in buying certain lines. For instance, in buying copper wire, copper and brass bar stock, steel and iron bar stock, and sheet steel, contracts can be made calling for the delivery of a certain weight or tonnage of materials of these classes within a specified time at a price a certain number of cents per pound, or dollars and cents per ton, over and above the current "base" price of the market value of the raw materials, such as ingot copper or steel, at the time of placing orders, or the average of such "base" price during each month may be stipulated as the basis of price.

Records of Former Purchases

For gathering statistical data on which to base estimates of future requirements and money expenditure involved, it is essential that a record of former purchases be kept. Such record should be classified by materials

MATERIAL Brass Bars				
SIZE 1/2" round				
SUPPLIER	Date of Invoice	Quantity Bought	Unit Price	Total Price
Bridgeport Brass Co.	1/15/15	560 lb	.12	67.20

FIG. 19.—Materials-Purchased Record Used as a Statistical Basis for Estimating Quantities of Materials and Supplies Consumed in a Given Period of Time, Showing Also the Past Cost

and show sources, quantity, and prices. Figure 19 shows a materials-purchased record of this form, indexed by materials and with a separate card for each size of material. These records are filled out from current invoices as they are received by a clerk in the purchasing department, who is assigned to the task of keeping up the record.

Record of Quotations

It is desirable to maintain records of quotations distinct from records of materials purchased. The reasons for keeping such a quotation record are: (1) It affords in compact form the names of firms that have made quotations in the past and from whom quotations can be secured again for the material under consideration; (2) it serves as a proof to show that competitive prices were secured.

The quotation record may be kept on cards or loose leaves ruled in a manner similar to that of the record of materials purchased shown in Figure 19, the only difference being that in the case of quotations there will usually not be so many detailed sizes and styles as in the record of actual purchases.

The Human Element in Buying

It goes almost without saying that the buyer must be on friendly terms with the suppliers and their representatives. Hence, a purchasing agent cannot afford to be haughty or "grouchy," nor should he be too busy to see salesmen. He certainly cannot give every salesman all the time that he would like to have, but he must have the good-will of as many of them as possible. In his capacity as department head he must be able to develop loyalty on the part of his assistants and clerks. In his dealings with department heads he will have to be diplomatic. Each department head naturally believes that his particular requirements and grievances should have precedence over all others, and the purchasing agent needs to have the friendship of the various department heads just as much as that of the suppliers' salesmen.

Requisitions on Purchasing Department

The management must designate a list of department heads authorized to make requisitions on the purchasing department. Such requisitions should bear the signature of the department head and the countersignature of either the works manager or the office manager, showing that he has approved them. In the interests of economy it

PENNSYLVANIA STATE COLLEGE—REQUEST FOR REQUISITION

DEPARTMENT OF Industrial Eng'g. | SCHOOL OF Engineering

QUANTITY	DESCRIPTION	ESTM. COST	
2000ft	California White Pine		
	Pattern Lumber		
	4/4" thick 10" wide	180	00

PURPOSE Pattern Shop | WANTED BY WHAT DATE

REQUIRED BY 2/10/15 DATE 1/10/15 | APPROVED BY H Brimer DATE 1/11/15

NUMBER OF REQUISITION 587 DATE 1/12/15 | PUT ONLY ONE ITEM ON A CARD G. H. Resides

FIG. 20.—Request for Requisition Sent the Department Head by Certain Designated Members of Department Authorized to Make Such Requests

is customary not only to allow the purchasing agent to make suggestions to the works manager or office manager in regard to requisitions, but also to encourage him to do so. Such suggestions, even in entirely technical materials and appliances, lead to a mutual understanding which is not developed if the purchasing agent is compelled to buy without questioning exactly what is specified. However, there should never be any departure from the specifica-

tions of the requisition when it has once been approved after inquiry and suggestion on the part of the purchasing agent.

Each department in turn should designate certain men as authorized to write out requests for requisitions. Such requests should be on a standard form. Figure 20 illustrates such a form. The request for requisition should

The Pennsylvania State College 1/16/15.

Williamsport Hard'Wood Lumber Co.,
Williamsport, Pa. No. I.E.587

SIRS:—Please furnish the following goods to the Department of Industrial Eng'g.
The Pennsylvania State College, State College, Penna., *to be shipped via* Freight

MAIL BILLS and CORRESPONDENCE IN REGARD TO THIS ORDER TO THE PURCHASING AGENT

SEND BILL OF LADING to the PURCHASING AGENT IMMEDIATELY UPON SHIPMENT of GOODS

ADDRESS GOODS TO THE DEPARTMENT DESIGNATED

QUANTITY	NAME OF ARTICLE
2000	California White Pine Pattern Lumber 4/4" thick, 10" wide

Yours truly, D. K. Hostetter
Purchasing Agent

Remarks

To Purchasing Agent. Get from Williamsport stock if possible.

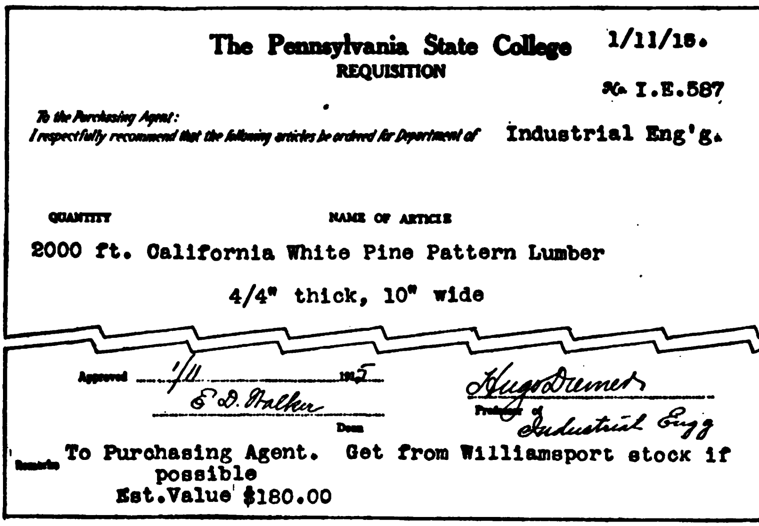
Est. Value $180.00

FIG. 21.—Purchase Order—the Original Copy, of Which Manifold Copies are Department Requisitions (See Fig. 22)

be returned by the department head to the person writing it, with the requisition number if it was written, and with reasons for cancelling or altering the request if it was refused.

In case the department head approves the request for requisition, he has a formal requisition on the purchasing agent written out. In some lines of business this requisi-

tion may be written out in manifold copies in such a way that one copy serves the purpose of the purchasing agent's outward order to the supplier. Figures 21 and 22 show forms of this character. The purchasing agent fills in the name of the supplier. He uses the department's requisition number as the purchase-order number, filing his office copy of the requisition by departments until shipment is


The Pennsylvania State College 1/11/15.
REQUISITION
No. I.E.587
To the Purchasing Agent:
I respectfully recommend that the following articles be ordered for Department of Industrial Eng'g.

QUANTITY NAME OF ARTICLE
2000 ft. California White Pine Pattern Lumber
4/4" thick, 10" wide

Approved 1/11 1915
E. D. Walker
Dean
Hugo Diemer
Professor of Industrial Eng'g
Remarks To Purchasing Agent. Get from Williamsport stock if possible
Est. Value $180.00

FIG. 22.—Department Requisition Written as a Manifold Copy
Original or top copy is sent to the purchasing agent and becomes his outward order.

made. In case of partial shipments, annotations are made on the office copy, which remains with unfilled outward orders until shipments are completed.

FILING PURCHASE-ORDER COPIES

One method of filing purchase-order copies is, as suggested in the preceding paragraph, to arrange them by the departments from which the requisitions emanate.

In case many requisitions come from a department, this may involve allotting a drawer or section of a filing cabinet to the requisitions from that department.

Where the requisition is of a different form from the outward purchase order, it is customary to file the requisitions according to the departments from which they emanate, making on each requisition annotations of the corresponding purchase-order number. A similar annotation indicating the originating requisition is made on the filed copy of the purchase-order number.

It is desirable that the purchasing department have a reference index or finding list for purchase orders arranged (1) by names of firms to whom the orders were sent; (2) by purchase-order number, so that, knowing the name of a supplier, we can see what outstanding orders he still has unfilled, and also, the purchase-order number being given, we can locate the purchase order. Such so-called "cross-references" can be written up in a loose-leaf index or card index, or the same purpose can be accomplished by having extra carbon copies of the purchase order written, one set being arranged alphabetically by name of supplier and the other being arranged in numerical order.

Following Up Purchase Orders

An important feature of the purchasing department is the so-called "tickler file." A file of this sort has a compartment for each day. The clerk in charge of the file brings the papers in question to the attention of the party whose name is indicated on a memorandum attached to the papers in the tickler file. After the papers have been selected which relate to deliveries due and not yet made, a follow-up letter is written and the papers filed under a new date in the tickler file, so as to come to

the attention of the proper person in the purchasing department at the new date. A follow-up postal card may be used for inquiring about a delayed shipment. In case the formal follow-up card does not bring results, there should be a series of carefully worded form letters and telegrams together with a plan for cancellation of orders, provided goods can be obtained elsewhere, as a penalty for the supplier's failure to live up to agreements as to delivery.

Financial Problems in Buying

The most apparent financial problem in buying is how to secure goods at the lowest price. This, however, is by

PURCHASING AGENT'S REPORT OF MONEYS FALLING DUE
BY REASON OF PURCHASE ORDERS ISSUED

Date Jan. 15, 1915

Req. No.	Ordered From	Descriptive	Amount	Date Due
I.E.587	Wmspt.H.W.L.Co.	Pattern Pine	180.00	Mar. 1/15
	TOTAL OUTWARD ORDERS FOR THIS WEEK			

FIG. 23.—Report of Accounts Payable Likely to be Incurred by Reason of Outstanding Purchase Orders

no means the only financial problem involved. It is exceedingly important for the management to know the financial liability involved by reason of outstanding purchase orders, as well as at what times the amounts in question will fall due. In other words, the management should receive a statement from the purchasing department showing, preferably by weeks, the amount of money

which will have to be paid out for incoming materials during those weeks. Such a statement enables the management to negotiate loans when necessary and to make arrangements to profit by cash discounts on large bills where these are from firms granting such discounts.

Figure 23 shows the form in which is made up such a statement of moneys falling due by reason of purchase orders issued.

Another statement which summarizes the invoices

Purchasing Agent's Report of Invoices Approved

Date Jan. 15, 1915.

Req. No.	Bought From	Descriptive	Accts. Payable Cr.	Material Dr.	Fin'd Stock Dr.	Mfg. Expense Dr.	Office Expense Dr.
687	Jones Printing Co.	Stationery	16.25				16.25
TOTALS							

FIG. 24.—Purchasing Agent's Report of Invoices Approved, Showing Accounts to Which Materials and Supplies are Distributed

Additional columns may be provided for equipment, tools, and sub-classifications of material and expense.

approved is illustrated in Figure 24. Such a one may contain more columns than are shown in the example. For instance, there may be additional columns for subdivisions of the raw-materials account, tools, equipment, and further subdivisions of the expense accounts.

RELATION OF RECEIVING AND STORES DEPARTMENTS TO PURCHASING DEPARTMENT

Inasmuch as the receiving and stores departments are engaged in the handling of materials, many lines of

business make these departments subsidiary to the purchasing department. The cost of conducting purchasing, receiving, and stores departments is in many enterprises considered an expense factor, designated as material burden, which is calculated as a percentage to be added to the invoice costs of material in order to determine the unit price at which work-in-process account is to be charged for all materials used in work in process. Such material burden would also include freight, express, and drayage on incoming materials in case these items are not added separately to determine the unit prices of raw materials. The organization, equipment, and systems used in the stores and receiving departments are described in the following chapter.

TEST QUESTIONS

1. What are some of the important questions, outside of buying, with which the purchasing agent has to deal?
2. What kind of knowledge must the purchasing agent possess in regard to the materials of the business in which he is engaged?
3. Describe a bureau of information such as should be maintained in a well-conducted purchasing department.
4. What sort of knowledge as to market conditions must the purchasing agent obtain, and what use should he make of such knowledge?
5. What sort of records should be kept relative to current and past purchases?
6. How should quotations be recorded?
7. How does the human element enter into buying?
8. What persons should be authorized to make requisitions on the purchasing agent for materials and supplies?

9. Describe the procedure and printed form in connection with requests for requisitions made by persons not authorized to make requisitions themselves.

10. To what extent should the purchasing agent take part in the preparation of specifications for materials and supplies?

11. How are persons making requisitions or requests for requisitions, informed what disposition has been made of their requests or requisitions?

12. How are purchasing-office copies of purchasing requisitions filed?

13. How are requisitions on the purchasing agent followed up?

14. What is a tickler file, and how is it used in a purchasing department?

15. What financial problems are involved in buying?

16. What sort of statement should be made relative to invoices approved during each fiscal period?

17. What are the arguments for and against making the receiving and stores departments subordinate to the purchasing department?

18. What is material burden?

19. Should materials be appraised at their invoice cost, or should material burden and inward freight and hauling be added in valuing materials and supplies for inventory purposes?

CHAPTER VI

RECEIVING, STORING, AND RECORDING MATERIALS

Determination of Material Requirements

In a continuous-process industry of the analytic type, when the capacity and output of the plant have been determined on, it is a comparatively simple matter to provide storage capacity for the raw materials and supplies, and to arrange by contract for a steady flow of these materials and supplies to correspond to the predetermined output.

In a synthetic industry of an assembling nature the problem of providing the materials in proper quantity and at the most advantageous times becomes more complex. Where the finished product is composed of a limited range of styles or sizes of a standard product, such as typewriters or sewing-machines, the requirements can be fairly well anticipated for a considerable future period.

Where only a portion of the component parts are made up in quantity on stock orders and the larger and more expensive parts are not put into work until definite sales are made, the problem becomes further involved. It is quite apparent that the only reliable basis for systems of receiving, storing, replenishing, and recording materials is a collection of material specifications or material lists covering everything in the way of raw

materials, supplies, finished parts built in the establishment's own shop, and finished parts bought outside, that go into the article to be sold.

Financial Importance of Materials

It has often been remarked that high-grade help is employed to take scrupulous care and keep perfect records of a company's cash, and that the same company's materials, supplies, finished parts, and finished product, though representing from fifty to one hundred times as much money as the company's cash on hand and in bank, are left to the care of low-grade and inadequate help. It would be well to compare the cost per dollar of cash handled by cashiers and clerks keeping cash book, petty-cash records, etc., with the cost per dollar's worth of materials and supplies handled by receiving and stores clerks and helpers.

Stores represent money. A cashier's office manned by help who could not discriminate between foreign and American coin, who kept cents in excess and dimes in insufficiency in petty cash, and who could not account for receipts and disbursements, is inconceivable; yet many large industrial establishments tolerate, in charge of their materials, help who handle the stocks in just the inefficient manner indicated. Money invested in needlessly large stocks or in incorrect stocks is inactive, and in most instances represents anything but "quick" or convertible assets.

Stores Accounting

A good system of stores accounting must provide a means of knowing:

1. What materials have been bought.
2. On whose authority they were bought.

3. What outstanding orders for material have been issued.
4. What materials have been disbursed.
5. What materials are required for present and future production orders.
6. To what person, order, or account all materials disbursed have been charged.
7. What balance of each kind of material is actually on hand.
8. What the balance or shortage is with regard to each item, deducting reserve for orders on hand.

Moreover, there must be a unit price for every item and a money value easily determinable for every classification indicated above.

The value of correct methods in keeping account of materials is so great that, in many cases where proper methods have been provided after a realization of the losses that were occurring from lack of information in this important field, concerns on the verge of insolvency have been put on a sound financial basis.

Material Specifications

All production orders, no matter what the class of business is, should first pass to a person or department whose duty it is to prepare complete specifications covering all materials required for the execution of these orders. It has been a matter of common experience that, when the bill of material is first introduced, no matter how expert or experienced the person may be who has prepared it, he will find, if he follows the actual production through the establishment by personal visits, that he has omitted numerous items of materials and supplies.

Figure 25 shows a form of material list as used in a concern building machinery and keeping accurate account of materials. A statement is first made of the particular type of product for which this list is made. A number is assigned to the material specification, so that, if it becomes standardized, it can be used again or so that it may serve for reference in ordering repair parts. The number of the order for which this specification is used

MATERIAL REQUIRED FOR	MATERIAL LIST No. [illegible]				
1 Press 6 A 4	SHEET ISSUED			ORDER No.	
FOR The Jones Mfg. Co.	MONTH Jan.	DAY 10	YEAR 1915		
WRITTEN BY	TO BE SHIPPED			SHEET No.	No. SHEETS
H. L. Smith	MONTH Feb.	DAY 15	YEAR 1915	1	4

Quantity	Article	Material	Piece Symbol	Pattern	Drawing
1	Shaft Collar	C.I.	F6 D8	P671	P788

CHECKED BY J L K APPROVED [illegible]

FIG. 25.—Material List Used in Assembling Type of Manufacturing Industry

is given, and likewise the date on which the sheets are issued, the number of sheets, and the date of shipment. Then follows a list of separate material items, giving the quantity of each, the name of the individual article, material of which it is made, the symbol, pattern number, and drawing number covering the individual piece, together with countersignatures of such officials or department heads as should check over the material specification.

This checking is important in many enterprises where minor changes in design may be found desirable. For instance, a brass piece may be replaced by a malleable-iron one, a wrought-iron piece by a steel piece, etc., and the change may not occur to anybody until the specification for a new order is being prepared. Checking at this point will frequently prevent changes while the work is in process, the latter procedure entailing wastes of material, labor, and clerks' time. Moreover, the disciplinary effect of knowing that a bill of material is correct and checked to the very letter is important. It shows that the management knows what it wants and expects to get exactly what is specified and nothing else.

Relation of Material Records to Various Departments

Figure 26 illustrates the connection between material records and various departments.

Path 1 shows how the sales department turns over its contracts to the order department.

Path 2 shows how the manufacturing committee, after deciding on a general manufacturing program, or the making of product or parts for stock, advises the order department of its decisions.

Path 3 shows how the orders are turned over to the technical department, which in a machine-building company would be the designing department, having a man or men assigned to the task of preparing bills of material.

Path 4 shows how the bill of material is turned over to the other stores clerks after it has been written. These clerks determine from their perpetual inventory sheets of stores what materials must be bought, what materials

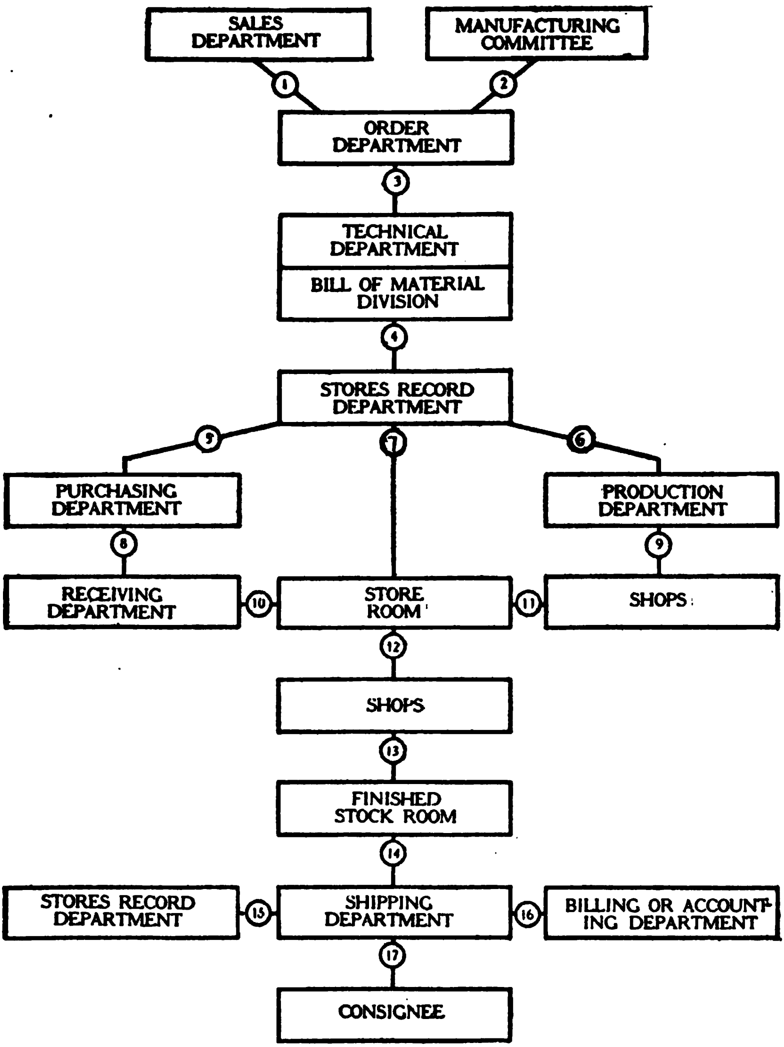


Fig. 26.—Chart Illustrating Relation of Material Records to the Various Departments of an Industry

are in stock, and what items must be made up in the shop.

Path 5 shows how the stores-record department makes requisitions on the purchasing agent for materials needed.

Path 6 shows how the stores-record department requests the issuance of production orders for the making up of detail parts on stock orders to replenish store-room stock of parts, or to make special parts for orders.

Path 7 shows the issuance of instructions to the store room to reserve certain parts for orders.

Path 8 shows how the purchasing department notifies the receiving department of outstanding purchase orders.

Path 9 shows how the production orders for component parts are sent to the shops.

Path 10 shows how the receiving department, after checking and reporting incoming goods, sends them to the store room.

Path 11 shows how component parts, after having been made in the shop and inspected, are turned into the store room.

Path 12 shows the reissue to the shops of parts and groups for assembly and erection.

Path 13 shows the transfer of completed product to finished stock room.

Path 14 shows the issue of finished product from the stock room to the shipping department.

Path 15 shows the notification by the shipping department to the stores-record department of shipment.

Path 16 shows notification of shipment sent to billing or accounting department.

Path 17 shows the shipment of goods to consignee and the shipping notice sent him.

At various stations there will be manifold copies of certain notifications going to the cost and planning or tracing departments. With these we shall not concern ourselves now, as we are primarily interested in the course-of-material and the record-of-material balances with their conversion into money values at such places and such times as may be essential to the realization of our principal aim, which we must always bear in mind. This aim is the following:

1. To know regularly once a month the money value of all materials received.
2. To know monthly the value of materials to be credited to stores and charged to work in process.
3. To know monthly the money value of work in process which has been converted into finished stock.

Knowing the foregoing items, we shall be in a position to determine the money value of our raw-materials or stores assets, the money value of our work-in-process assets, and the money value of our finished-products or finished-stock assets. Having these data in terms of dollars and cents, we can prepare a monthly balance sheet of the entire business instead of waiting for an annual physical inventory. We have already illustrated the bill of material, which is the natural starting-point of the required records. The stores-department records are the next set which we shall have to detail.

Perpetual Inventories of Stores

The operation of a perpetual inventory of stores is best explained by inspecting a typical balance-of-stores ledger sheet. This is illustrated in Figure 27. At the top of this sheet there is a space for a description of the article. At the upper right-hand corner there is a space for the

BALANCE OF STORES LEDGER

Acct. No. ______
Ref. No. ______
Low Limit ______
Description ________________________________
________________________________ Quantity to be ordered ______
Section ______ Bin ______ Unit Quantity ______ Unit Price ______

Ordered			Received			Reserved		Issued		Balance	
Date	Quant.	Req. No.	Quant.	Cost Unit	Date	For Order No.	Quant.	On Order No.	Quant.	In Store Room	Deducting Items Reserved

FIG. 27.—A Typical Perpetual Inventory Sheet

"Account No." This is used if stores are classified as to their serving certain departments. For instance, foundry materials and supplies might constitute a certain account number, while forge-shop materials and supplies constitute another account number. The space for "Reference No." is filled in either with the number or mnemonic identification mark of the piece, this symbol being the abbreviation or shop term used on withdrawal orders, time tickets, and elsewhere, to economize time and space. For instance, in designing a mnemonic-symbol system we might first use a letter to indicate a certain group, as for example H for hardware group; then would come a subdivision of the group, as for example Ca for catches, and a further symbol to indicate the size, number, or other description of the material. For instance, bronze cupboard catches would be indicated as HCaCBr, and this symbol would be followed by a number, if there were a specific number or size designated.

A further annotation in the upper right-hand corner of the sheet refers to minimum stock to be carried. This is filled in with a number only when the use of the article is thoroughly standardized. In all other instances a rubber-stamp entry, "Report to Production Department," is inserted. It is not wise to leave to the discretion of a stores-record clerk the replenishment of stocks of materials which in many cases may be in a transitional or obsolescent stage.

Next on the sheet follows the location of the article as to the section of the store room and the bin in which it is located. Then comes the unit, whether pounds, feet, dozen, one, etc., and the money value of one unit, space being allowed for changes in the money value per unit.

Where a perpetual inventory is kept and monthly balances of the money value of stores on hand, received,

and issued are reported, it is customary to include inward freight and hauling (and sometimes also a percentage to cover cost of buying, receiving, and storing) in the unit prices at which materials are charged to work in process or manufacturing expense, but the amounts thus charged to stores do not appear in the expense account. This procedure is coming to be recognized among accountants and appraisers as not only legitimate but correct, inasmuch as inward freight and the cost of buying, receiving, and storing material increase the replacement value of material and constitute in a going concern an asset and not a loss. By charging inward freight and drayage and cost of buying, receiving, and storing to a general expense or other revenue account, we are undervaluing our stores.

Making Entries in the Stores Ledger

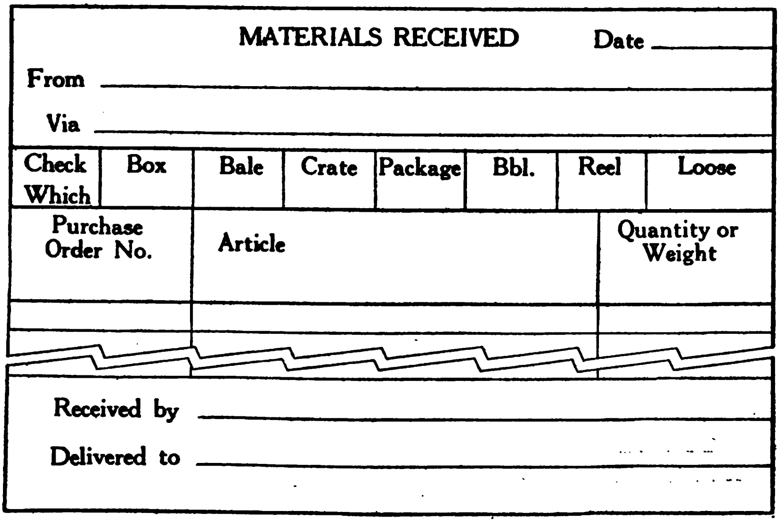
The stores ledger has usually five groups of columns relating to the following transactions: (1) goods ordered; (2) goods received; (3) goods reserved for orders; (4) goods issued; (5) goods available.

The entries in the columns referring to goods ordered are made from copies of purchase requisitions. The entries relating to goods received are made from copies of receiving-clerks' reports. The entries relating to goods reserved for orders are made from the bill of material. The entries relating to goods issued are made from copies of withdrawal slips or orders on store room and from shipping reports. The balances relating to goods available are easily struck when the preceding sets of columns are properly filled. The forms for bills of material and purchase requisitions have already been considered. We have still to consider the reports from the receiving department, the withdrawal slips covering

goods issued, and shipping memoranda relating to goods shipped.

ENTRIES RELATING TO GOODS RECEIVED

The receiving department should render reports covering all materials received from outside. Such reports are sometimes made in the form of a single one referring



MATERIALS RECEIVED Date

From

Via

Check Which	Box	Bale	Crate	Package	Bbl.	Reel	Loose

Purchase Order No.	Article	Quantity or Weight

Received by

Delivered to

FIG. 28.—Materials-Received Report used by Receiving Department for Separate Report on each Inward Consignment

to receipts from various sources or in the form of a separate sheet for each distinct incoming consignment. The latter form is more flexible, as a rule, although it occupies more paper.

Figure 28 illustrates a form for reporting receipts of material in which a separate report is used for each inward consignment. This report is usually written in manifold, an autographic-register machine being fre-

quently found advantageous for this purpose. One copy is kept on file in the receiving department, another sent to the purchasing department, another to the stores-record department, and sometimes another to the production department.

Another source of receipts by the store room would be material returned by the shop. For material returned in

STORES CREDIT

Received from | Req. No. | Order No.

Quantity	Material Received	Cost Unit	Amount
	(Use for one item only)		

Remarks

Date

Store Keeper

FIG. 29.—Credit Memorandum Covering Items Returned to Store Room

this manner a stores-credit memorandum is used, illustrated in Figure 29.

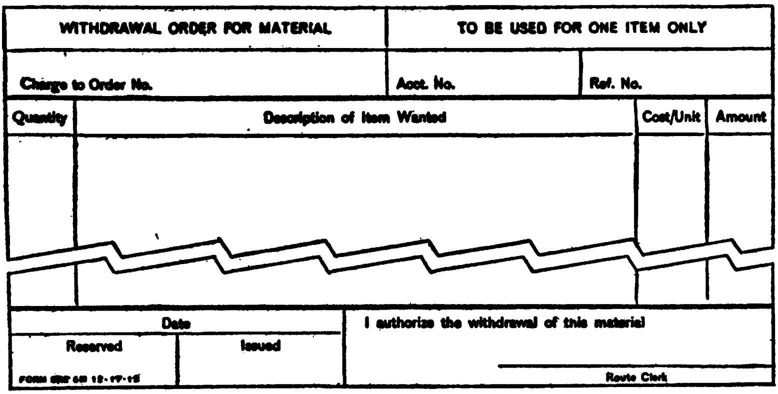
ENTRIES RELATING TO GOODS ISSUED

Two types of reports relating to goods disbursed have been mentioned: (1) those relating to raw materials or finished parts issued to the shop and (2) finished stock shipped outward by the shipping department.

Figure 30 illustrates a form for withdrawal order for material. In a well-organized shop these withdrawal

orders for material are prepared at the same time with the material list, being written out in advance and stored in a pocket in a large fibre-board portfolio designed to hold all the various papers, drawings, lists, etc., relating to a given order.

Reports from the shipping department are made in the form of a shipping memorandum or packing list. This is also written in manifold, one copy going to the order department, one to the billing clerk, one to the stores



WITHDRAWAL ORDER FOR MATERIAL — TO BE USED FOR ONE ITEM ONLY

Charge to Order No. | Acct. No. | Ref. No.

Quantity	Description of Item Wanted	Cost/Unit	Amount

Date: Reserved | Issued

I authorize the withdrawal of this material

Route Clerk

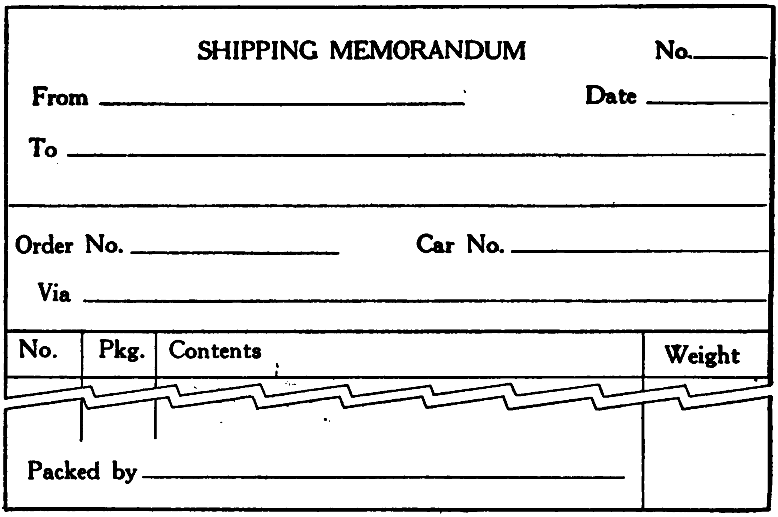
FIG. 30.—Withdrawal Order for Materials Issued from the Store Room

record, one to the consignee, and one remaining on file in the shipping department. Figure 31 illustrates such a memorandum.

Physical Features of Store Rooms

The stores of an industry, although the records and perpetual inventory may all be kept in one place, may have to be distributed in rooms or buildings most convenient to the efficient handling of materials, each separate store room being provided with the necessary clerical and laboring help, all being under the supervision of the gen-

eral head of stores department. For example, castings may have to be located near the first machining processes; bar stock for the forge-shop may have to be located near the forge-shop; finished machined parts may be midway between the machine tools and the assembling and erecting department, and finished product may have to be adjacent to the shipping department.


SHIPPING MEMORANDUM No._____
From _____ Date _____
To _____
Order No. _____ Car No. _____
Via _____

No.	Pkg.	Contents	Weight

Packed by _____

FIG. 31.—Memorandum of Materials Shipped

Careful attention must be given to the location of store rooms and stores buildings as essential features in an industrial plant. The store rooms and buildings must be designed so as to prevent overcrowding. There must be room for the passage of trucks, good natural and artificial light, room for expansion, and often bins and racks must be designed for special purposes. A pneumatic-tube service system between all the departments handling material records is frequently desirable, since it permits

of more continuous and up-to-the-minute accounting than a factory mail-delivery system. Dumb-waiters to various floors and cable-driven baskets for light goods are also frequently installed. A standard form for sections and bin units has already been suggested.

It is quite apparent that the handling of materials of all sorts affords opportunity for the best managing ability and is a most fruitful field for developing economies and increased efficiency of production.

TEST QUESTIONS

1. How may we determine in advance the approximate annual material requirements of an industry?

2. What is the argument in favor of high-grade help in the stores department?

3. What information should be disclosed by a complete system of records of stores receipts and disbursements?

4. What is a material list or bill of material? What use is made of it in connection with stores records?

5. Indicate by a chart the relation of material records to the sales department, the order department, the designing department, the stores department, the purchasing department, the receiving department, the production department, and shop.

6. What monthly financial summaries should be recorded and reported by the stores department?

7. Make a sketch of a balance-of-stores sheet as used in a perpetual stores-inventory system.

8. From what source is information received relative to goods ordered?

9. From what source and in what manner is information received relative to goods received?

10. From whom and how is information received relative to goods reserved for orders?

11. From what source and in what manner is information received relative to goods issued?

12. Where is a good location for storing the following: (a) iron castings; (b) bar stock for forge-shop; (c) finished machined parts; (d) complete finished and assembled product?

13. Discuss the desirability and practicability of (a) pneumatic-tube service system; (b) dumb-waiter stores delivery system; (c) cable-driven stores service basket system.

14. Under what conditions is it preferable to have a number of distinct store rooms rather than one large central store room?

15. Why is the perpetual stores inventory preferably kept near the cost and production records rather than in the store room?

16. Why will bin-ticket records not answer the same purpose as perpetual inventory sheets kept adjacent to the stores and production records?

17. Why should stores-record clerks not be permitted to issue replenishment orders without approval by higher authority?

18. Would you recommend verifying the paper perpetual stores inventory by some system of physical stock-taking? If so, what system would you recommend?

19. If a man is a laborer or window clerk in a store room, how can he train himself for promotion to a more responsible position?

20. What provision should be made for recording materials returned to the store room?

X CHAPTER VII

PLANNING

PLANNING OF INDUSTRIAL ACTIVITIES IN ADVANCE

This has come to be recognized as an important and necessary feature of management. The general manager must forecast future trade, labor, and market conditions from his knowledge and study of the statistics of the industry in question. He must shape the future policies of the business so as to make them coincide with the wishes of the directors. He must devise improved methods of management, assisted in this by his principal subordinates.

The planning of all of the industrial activities is a much more comprehensive problem than looking ahead in the shop alone. The same principles underlie this larger problem as form the basis of shop-planning. Shop-planning methods were introduced because it became evident to the progressive manager that mechanics looking for blue-prints, tools, fixtures, materials, and supplies, and waiting to be told which job to do next were losing valuable time. Very often the next job assigned by the foreman was selected on the basis of expediency, being the job most easily found or most readily disposed of, instead of being the most important job to be done next.

Comprehensive planning involves:

1. Finances.
2. Sales.
3. Production.
4. Labor.
5. Plant.

Figure 32 is a chart illustrating comprehensive planning along the lines indicated.

Planning as to Finances

The treasurer or comptroller will consult with the sales, order, and accounting departments as to what money is coming in and when it is coming in. He will consult with the purchasing department, pay-roll department, and accounting department in order to get information as to what money is going out and when it will have to be paid. Using both of the above classes of information as a basis, he will have to determine what money, if any, is to be borrowed, what securities can be offered for loans, also whether it would be advisable to present to the board of directors any proposals as to sales of unissued capital stock, increasing the capital stock, or issuing bonds.

Planning as to Sales

The sales manager will have to determine first of all what to sell. If the output of the industry is at all varied, the sales manager will have to plan on what classes of finished product to lay greatest stress. The selection as to what to sell will be based on (1) consideration of what is the most profitable product; (2) what is in greatest and most steady demand. He will have to plan next how

PLANNING INDUSTRIAL ACTIVITIES

- **I. As to finances**
  Treasurer or Comptroller
  - What money is coming in and when
  - What money is going out and when
  - What money must be borrowed or raised and how
- **II. As to sales**
  Sales Manager
  - What to sell
  - How much to sell
  - How to sell it
- **III. As to production**
  Works Manager
  - What work is to be done
    Production Manager
    - Secures data from:
      - Sales department
      - Designing department
      - Manufacturing committee
      - Order department
      - Stores department
      - As to definite and probable future work
  - What materials are required
    Stores Manager
    - Secures data from:
      - Bill of material department — As to materials needed
      - Stores department — As to what is on hand and what has to be bought or made
      - Purchasing department — As to outward orders
  - Where work is to be done
    Route Manager
    - Secures data from:
      - Production department — As to what is to be made
      - Routing department — As to where to do the work
  - How work is to be done
    Time Study and Instruction Manager
    - Secures data from:
      - Time study department — As to detailed methods and time
      - Inspection department — As to accuracy
  - How long work will take and when it shall be done
    Order of Work Manager
    - Secures data from:
      - Sales and order departments — As to when work is wanted
      - Cost department — As to how long work usually takes
      - Order of work department — As to work ahead at each machine, bench, or other production center
- **IV. As to employment**
  Employment Manager or Superintendent
  - What kind of men and how many to employ
  - What kind of men and how many to drop
  - Whom to promote
  - What welfare, social safety, and educational activities to conduct

FIG. 32.—Chart Illustrating Planning

much to sell. In this he will be guided primarily by considerations as to capacity of the shop.

He will have to plan also as to how to sell the product. This involves consideration of whether salesmen shall be on a commission or salary basis, or on a combination of both. It involves the question of whether there shall be branch offices or whether salesmen shall all have their headquarters at the main plant. It involves also the routing or planning of the visits of salesmen in advance, giving them definite instructions as to whom to interview and on what days to do this. It includes also the question of advertising and how much shall be expended so as to secure the best results.

Planning as to Production

The planning of production in advance involves the following considerations:

1. What work is to be done.
2. What materials are required.
3. Where work is to be done.
4. How work is to be done.
5. How long work will take and when it shall be done.

If the shop superintendent and shop foreman can be relieved of all of the planning indicated, they will be free to devote their entire attention to carrying out successfully the work in hand. However, in order that the planning may be systematically carried out, it is essential to classify it as indicated and to make certain department heads definitely responsible for such systematic planning.

Planning Department as Designed by F. W. Taylor

This writer on shop management advocates four functional heads in the planning department, namely:

1. The order-of-work and routing clerk.
2. The instruction-card clerk.
3. The time-and-cost clerk.
4. The disciplinarian.

In addition to the four leading functions which he lists, he states the following as the activities of the planning department:

1. The complete analysis of all orders for machines or work taken by the company.
2. Time study for all work done by hand throughout the works, including that done in setting the work in machines, and all bench and vise work, transportation, etc.
3. Time study for all operations done by the various machines.
4. The balance of all materials, raw materials, stores and finished parts, and the balance of the work ahead for each class of machines and workmen.
5. The analysis of all inquiries for new work received in the sales department and promises for time of delivery.
6. The cost of all items manufactured with complete expense analysis and complete monthly comparative cost and expense exhibits.
7. The pay department.
8. The mnemonic-symbol system for identification of parts and for charges.
9. Information bureau.
10. Standards.

11. Messenger system and post-office delivery.
12. Employment bureau.
13. The shop disciplinarian.
14. A mutual accident-insurance association.
15. Rush-order department.
16. Improvement of system or plant.

Modified Taylor Planning Department

Mr. Frederick A. Parkhurst, who applied Dr. Taylor's principles to the organization and management of the Ferracute Machine Company, Bridgeton, N. J., puts the planning department in charge of a man designated as "production clerk." The production clerk has one substitute, who assumes his duties during his absence. Those employed in the planning department proper are as follows:

1. Production clerk.
2. Shop engineer.
3. Stores clerk.
4. Cost clerk.
5. Route clerk.
6. Order-of-work clerk.
7. Shipping clerk.
8. Receiving clerk.
9. Time clerk.
10. Schedule clerk.
11. Factory mail boy.
12. Time boy.

In addition to the above, but directly responsible to the production clerk, the shop employs the following:

1. Inspector.
2. Stores keeper.
3. Move-material boss.

The three last named are all functional foremen, each having specific duties which are clearly defined in writing and which may bring all of them successively in touch with each and every man in the shop. They practically

form the shop representatives of the planning department, which really controls and runs the shop through them. Those employed in the planning department are likewise filling functional positions.

Separation of Planning from Routine Activities

An inspection of the various activities listed above under the general supervision of the so-called "planning department" shows that those collected by Taylor and Parkhurst under one general head not only have to do specifically with the planning of production in advance, but involve routine production records and statistics collected by various individuals who secure continuous running data for the guidance of the men who are actually engaged in the planning ahead, on the one hand, and certain other individuals who see that the production is carried out in accordance with the planning. It follows that, in a well-organized planning department, there must be certain heads who are free from routine work and who can devote their entire energies to planning and executing. Figure 32 endeavors to emphasize the distinctly planning and executing functions.

The chart in this figure places the works manager in charge of the planning department. The title "works manager" is more suitable than that of "production clerk." The so-called "production clerk" in the Taylor and Parkhurst organizations is, in fact, the works manager. Figure 32 also gives the titles "production manager," "stores manager," "route manager," "time-study manager," and "order-of-work manager" to the men who must do the actual planning in these important activities.

To pick out the best foremen or department heads in an industry and then designate them merely as "clerks"

or "bosses" looks too much like a come-down to the men, whereas, if they are called by the titles indicated, they will feel that they have had a promotion. There is no more danger of their having exaggerated ideas of their importance through receiving these titles than is the case in the large department stores, which long since adopted the title "department manager" as the most desirable one.

Planning Work in the Shops

Reference to Figure 32 shows that this function is allotted to the production manager, who is the first assistant to the works manager and takes the latter's place as head of the planning function in his absence. He secures his data from the sales department, the designing department, the order department, and the manufacturing committee, and censorizes all of the so-called "automatic replenishment" of standard stock-production orders that come up as a development of the balances shown by the perpetual inventory of stores. From his contact with the sales department and designing department he will be in a position to know what items are likely to become obsolete and what items will probably be in strong demand.

PLANNING MATERIALS FOR SHOP ORDERS

In Chapter VI were detailed the various departments and statistics that dealt with materials. To co-ordinate all of these statistics and records and to see that all requirements are properly taken care of, there needs to be a functional head who has no routine duties but is free to plan and execute with reference to material requirements. Figure 32 centers this responsibility on the stores manager. He secures from the bill-of-material

department data as to materials needed, from the clerks in his own department as to balances on hand and what has to be bought or made, and from the purchasing department as to outward or purchase orders and deliveries promised on the same.

PLANNING WHERE WORK IS TO BE DONE

This responsibility is centered in the route manager in Figure 32. He secures his data from his own department. He needs to be supplied with exhaustive information as to the equipment and processes of the industry. He should be a technical man, so far as the processes are concerned. He is assisted by having models and drawings of the plant showing the location of equipment and the process-maps. His department designates what department and what machine or group of similar machines will have to perform operations on each order. He secures from the production department data as to orders in hand. He issues standard route sheets for standard product and has new route sheets prepared for new pieces, groups, or product.

These route sheets are of two classes: (1) individual-piece route sheets; (2) general route sheets. Individual-piece route sheets list the operations and machines required for making an individual piece. For the sake of economy of time and space as well as to avoid unnecessary publicity, mnemonic symbols are generally used to designate the names of the operations and the names of the machines involved.

Individual-piece route sheets can be put on card indexes for general reference, and they may be advantageously reproduced in the lower right-hand corner of detail drawings blue-printed for shop use. Figure 33 shows a detail route sheet of this form. It will be

noticed that it gives first the complete name of the piece; second, its mnemonic symbol, this being the abbreviation by which it is designated on work and material orders. Then follow the operations listed in regular sequence, separated by the natural dividing-line between the work done by one man and the work done by the next man to whom the work is passed. For each operation there is an abbreviation or mnemonic symbol. The tool symbol indicates the machine, vise, or fitting space to which the route department assigns the piece. The last column refers to a specific instruction-card number.

DETAIL ROUTING

Piece Name Wrist Plate Stand Pin for 12" cylinders Piece Symbol P W P S 12

Operation No.	Operation Name.	Operation Symbol	Tool Symbol	Instruction No.
1	Center & Rough Finish	CFR	L 1	1621
2	Grind	G	G 2	1622
3	Fit	F	F 2	1623
4	Drill & Tap	DT	D 3	1624

FIG. 33.—Detail or Individual-Piece Route Sheet or Card, Often Listed on Blue-prints

The instruction card is a detailed expansion of the operation. For each operation there may be from twenty to a hundred distinct motion and time elements which are detailed on the instruction card. The extent to which the instruction card goes into detail will vary with the nature of the business.

PLANNING HOW WORK IS TO BE DONE

This responsibility is centered in the time-study and instruction-card manager. After the detail route sheets

are prepared, the time-study and instruction-card department consults its records to see whether time studies and instructions are available for every item. In case they are not, such as are deemed necessary are made and detailed instructions are written up on the basis they afford when combined with standard time elements on file.

A detailed discussion of the principles and methods of time and motion studies and their relation to instruction cards and labor efficiency is given in a later chapter.

PLANNING WHEN WORK IS TO BE DONE

The responsibility of planning how long work will take and at what time it will be completed is centered in the order-of-work manager. He secures from the sales department and order department data as to when work is wanted, and is in turn consulted by them as to the time at which delivery can be guaranteed. He secures data from the cost department as to how much actual time has been consumed in the past, not only in the actual work on certain types of product, but as to the elapsed time between the beginning of work and its completion. From the records in his own department he has positive knowledge as to the work ahead at each bench, machine, or other production center. These dates are posted on a record in which a card or sheet is kept for each machine, vise, or other production center. Such a form is illustrated in Figure 34. The postings on this form indicate the balance of work ahead at each production center.

As a result of investigating these balances, a definite date is determined at which each individual part will leave each machine or production center. These dates are then posted on a so-called general "route-and-time sheet," one of these being prepared for each group or

completely assembled machine or other product. This form is illustrated in Figure 35. At the left-hand side of the form are listed in a column the symbols of the various pieces which go to make up the group. To the

WORK ASSIGNED TO MACHINE No. ______

Work Assigned to be Added			Balance Hrs. Work Ahead	Work Completed to be Deducted		
Order No.	Piece Symbol	Time Allowed		Order No.	Piece Symbol	Time Taken

Fig. 34.—Record for Keeping Balance of Work Ahead at Each Machine, Vise, or Other Production Center

GENERAL ROUTE AND TIME SHEET

For Corliss Wrist Plates for 12" cylinders

Order No. 1625 Required by 2/15/15 No. Pcs. 10

Piece Symbols	Tool Symbols and Dates Due																								
	B				D				F			G			L			M		P		S			
	1	2	3	etc.	1	2	3	etc.	1	2	etc.	1	2	etc.	1	2	etc.	1	etc.	1	etc.	1	2	3	etc.
F W P S 12							1/25			1/20			1/15		1/10										

Fig. 35.—Record of Date at Which Each Component Part Is Due at Each Machine, Vise, or Other Production Center

right are other columns in which are listed the various separate machines, vises, and production centers of the plant, a separate column for each one. In the illustration these columns have been condensed. In a shop having a large number of machines, this form may have to be

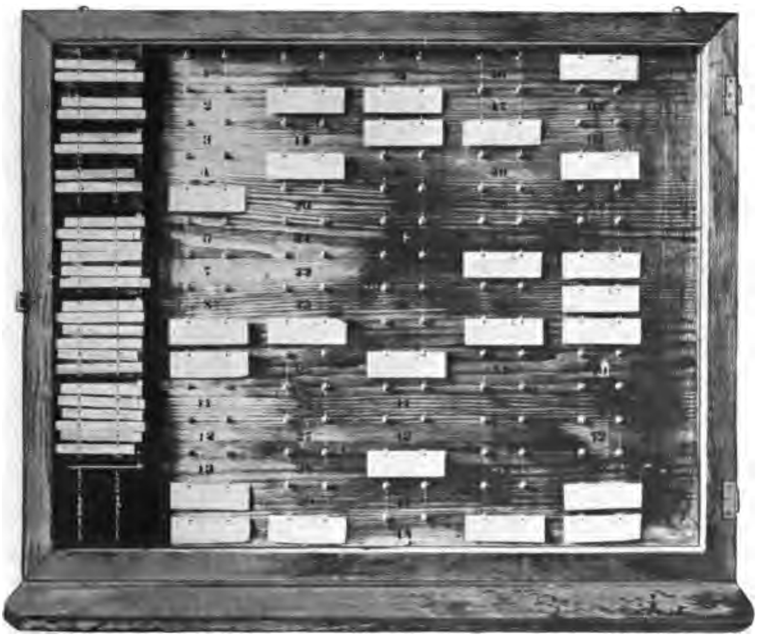


FIG. 36.—Shop Bulletin Board on Which are Listed at the Left the Assignments to Specific Machines, Benches, or Other Production Centers of Workmen in the Department, and at the Right the Work Ahead at that Machine, Bench, or Other Production Center

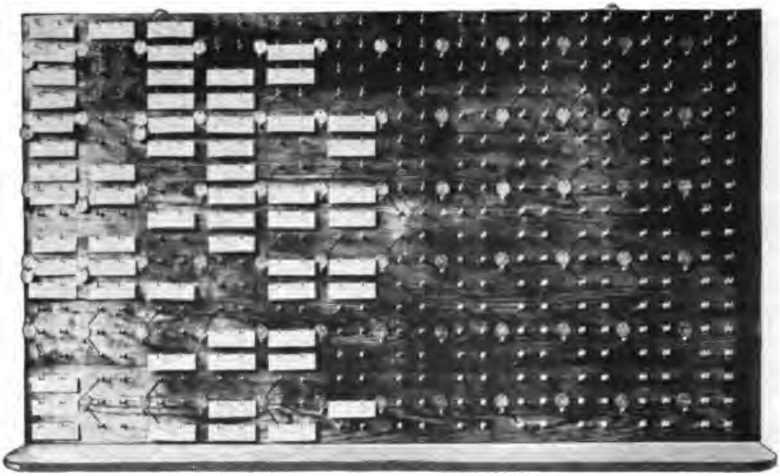


FIG. 37.—Planning Department's Office Bulletin Board for Scheduling or Dispatching Purposes, Showing Work in Process and Ahead at each Machine, Bench, or Other Production Center

wide enough to fold or it may be composed of several sheets fastened together. The date at which the piece is expected to leave each production center is then indicated in the proper column as shown.

It is the duty of the order-of-work manager to see that each job is begun in the order in which his department has designated. He is assisted in this work by the use of bulletin boards. In each department there are two bulletin boards. The first (Fig. 36) shows what work each man is doing. At the left-hand side of this bulletin board are listed the names of the men in the department together with their check or clock numbers. Opposite each man's name is the symbol of the machine or production center to which he is assigned together with the numbers of certain hooks on the bulletin board on which hang little paper slips indicating the jobs assigned.

The second bulletin board (Fig. 37) has a series of three hooks for each machine or production center in the department. The upper hook has hanging on it the job on which the man is working. The next hook has jobs ahead at the machine or production center in the order in which they are to be worked. The third hook has jobs to be worked at in the future, but which are not as yet at the machine.

In the central office of the planning department, at a window which opens out on the main shop floor and is connected by chutes to the other shop floors, is a master board containing duplicates of the three-hook type of bulletin board for each department or section of the shop. As work is completed, the slips of paper representing work at the machine are removed by the workmen, checked by the gang boss or time clerk, and brought to the window of the planning department, where the correctness of the

procedure is verified and the progress of the work recorded on the tracing sheet illustrated in Figure 38.

An alternate method is to have a clock stamp at each foreman's or gang boss's headquarters to enable him to stamp the time of completing each job. The move-

INDIVIDUAL PART TRACING RECORD

Piece Symbol P W P S 12

PIECE NAME Wrist Plate Stand Pin for 12"cylinders

Order No. 1625 Req'd by 2/15/15 No. Pcs. 10

OPERATIONS	Material Moved	Operation Performed	Inspected
DRAWING FINISHED			
PATTERN MADE			
MATERIAL ORDERED			
MATERIAL IN STORES			
ROUTING READY			
INSTRUCTION CARD READY			
TOOL LIST READY			
SKETCH READY			
DETAILED OPERATION SYMBOLS:			
CFR			
G			
F			
DT			

FIG. 38.—Tracing Record, Showing Progress of Work on each Piece
The heavy black line shows how far the work has progressed.

material man on his regular trip takes completed work to the next operator or department, carrying the job slips for completed work to the planning or production office window. This latter method does away with the neces-

sity of having the workmen or mechanics spend any time in carrying the slip to the window.

Planning as to Employment

Responsibility in this field is centered in the employment manager or superintendent. He secures from the production manager and the order-of-work manager data as to the amount of work ahead and when it is to be completed, and he determines when he must put on additional men and when he must lay off men. With well-organized planning, however, these fluctuations in the number of employes will be smaller than under traditional management. Planning as to employment involves the consideration of the kind of labor to use. The labor force may consist of:

Men
Women
Children

A careful analysis of the work and of the working conditions is required to make an intelligent choice along this line. Economic, humanitarian, and legal conditions must be balanced against each other. Natural aptitudes, physical endurance, permanence of employment, initiative, problems of supervision, labor-union activities, and similar matters should be taken into consideration. Each class has some special advantages and the wise employer will not overlook them.

Even more subtle employment factors must be adjusted to the employment problem. Standards should be used as to the degree of mental and physical energy required in the work. A rough classification as to skilled or

unskilled labor is desirable. This requires an analysis of the exact demands of each machine in operation. Some machines require mere supervision over supplies, the attendant doing simple unskilled labor. Others require simple adjustments to be made from time to time. Still others require a high degree of skill and considerable training in the correct operation of the machine. With all of this information at hand, the employment manager is able to specify pretty definitely the kind of labor that he wants much in the same manner that the purchasing agent uses his standardized specifications of materials.

The question of wage payment might well be included in planning as to employment. It makes considerable difference whether time, piece, premium, bonus, differential piece rate, or other systems of wage payment are used. Decision must be made as to whether the job is to be treated on a salary or on a wage basis.

The employment manager must be planning as to where he can get additional help to fill new places or to fill the places of men who are leaving. He will assign a man to continuous duty on this important question, as well as on the matter of individual efficiency of the various men in the shop. He will plan with regard to welfare, social, educational, and athletic activities among employes, assigning a capable man to this work. A more completely detailed description of methods in this field is given in a later chapter.

Does Planning Mean Additional Non-productive Labor?

A superficial examination of planning methods frequently misleads proprietors, managers, and superinten-

dents accustomed to traditional methods, so that they form the opinion that planning means exceedingly high overhead expense. In actual practice, however, it has resulted in remarkably increased production with the same number of men and machines. Under an efficient system of planning no new work is introduced into a business enterprise. It means simply the scientific distribution of the planning work engaged in under traditional management by all classes of foremen and clerks. A scientific planning system introduces the principle of specialization of labor to the work of planning by allotting to each man the kind of work to which he is best adapted.

At the plant of the Tabor Manufacturing Company, in Philadelphia, the introduction of a planning department resulted in an almost doubled output without any increase in the total number of employes or equipment. However, it is important to bear in mind that the members of the planning or production department are not clerks or experts hired from outside, but are the very best men already in an existing organization. For this reason it is desirable to use the title "department manager" rather than the designation "clerk" or "boss."

The designation "planning department" is also apt to be somewhat misleading, since planning has to be done by all of the leading officials and department managers. To be sure, the works manager's office and the subsidiary department managers under him do most of the strictly shop planning, but the chart in Figure 32 shows that equally important planning must be done by other officials. The principles involved are the same in the case of each department or official considered. The important department head or official must be left free from detail routine, in order that he may think and plan, but there

must be thoroughly systematized methods of having available data to help him in his thinking and planning, as it is only through the combination of these conditions that he can accomplish satisfactory results.

TEST QUESTIONS

1. What sort of planning in advance by the general manager is essential?

2. What sort of planning in regard to finances must be carried on by the treasurer or comptroller?

3. Discuss the kind of planning as to sales which must be carried on in the sales manager's office.

4. What considerations are to be covered by the planning as to production?

5. Describe the planning department as designed by F. W. Taylor.

6. How does the planning department as used by Frederick A. Parkhurst differ from that designed by F. W. Taylor?

7. Draw a chart showing the organization of a planning department in the production division.

8. What data and methods are involved in planning the work to be done in the shops?

9. What data and methods are necessary to plan for materials required for shop orders?

10. What information is necessary to plan intelligently where work is to be done?

11. What information is necessary in order to plan how work is to be done?

12. What information is necessary in order to plan how long work will take and at what time it will be completed?

13. What justifies the additional overhead expense involved in installing a planning department?

14. What planning should be done with regard to employment questions?

15. Why could not the superintendent and foreman attend to all the shop planning?

16. What is left for the shop foreman to do when the planning is all done by others?

17. Do members of the planning division give orders directly to men in the shops? If not, how are their orders carried out?

18. Do you think workmen in a shop having a planning division would be likely to quit on account of having too many bosses?

19. If you were about to establish a planning division where would you go to look for men to fill the positions of route clerk, order-of-work clerk, and instruction-card clerk?

20. Do you think planning-department principles could be applied to one's personal private life? If so, how?

CHAPTER VIII

THE DETERMINATION OF COSTS

Inaccurate or Inadequate Costs

Almost every industrial establishment carries on some kind of system of records relating to costs, yet it is notoriously true that the most important members of the managing staffs of these establishments have, as a rule, a very meagre knowledge of the elements which go to make up the costs of their product. Frequently they have still less knowledge of the detailed items of cost involved. Generally they have given but little thought to the question of whether the cost methods which they are following are those best adapted to their particular industry. Frequently they may be of the opinion that they are using the best possible cost system for their business.

However, this opinion is often the result of self-satisfaction and does not at all arise from a thorough comparative study of cost-keeping as a whole. Even after such a general study many fail to make an adequate application of cost-keeping methods to their particular industry.

Probably the chief reason for inaccurate cost systems is that the subject of cost accounts has not received extensive and exhaustive attention on the part of the management. In the average business the tremendous advantages to be gained from scientific cost-accounting

methods in the way of cost reductions are not realized. As a rule, only two purposes are served by the traditional cost system. These two purposes are among the very least of those which can and should be served by a scientific cost system. They are as follows: (1) The traditional cost system gives the billing department some kind of basis for establishing prices on repair parts; (2) it also furnishes retrospective information to the superintendent when a job has apparently cost a great deal more than the same or a similar job cost according to previous records.

Another reason for inaccurate costs is that the work of cost-keeping is left to poorly paid clerks. The head of the cost department is usually burdened with so many duties and so much routine work that he has no opportunity to plan or study. It is quite customary for a corporation with a business of a million dollars a year to have a thousand-dollar-a-year cost-department head, although the head accountant and purchasing agent are paid three times this salary. A company doing a business of a million dollars a year could unquestionably get far better results with a cost department consisting of a head at three thousand dollars, a first assistant at fifteen hundred dollars, and two clerks at a thousand dollars, making a total of sixty-five hundred dollars, than could be secured with a cost department in which the head is paid a thousand dollars, and having ten clerks at six hundred dollars each, making a total expenditure of seven thousand dollars.

Need of Accurate Costs

The need of accurate costs is thoroughly demonstrated when manufacturers of similar commodities, such as machine tool builders or furniture builders or shoe manu-

facturers, get together and discuss cost accounting. Different cost systems, as will be later demonstrated by numerical examples, result in the most widely fluctuating apparent costs, leading to absurdly ruinous competition, the tendency being always to meet the lowest selling price offered.

In the metal trades a common example of absurd competition is afforded when an establishment which has been building a limited line of medium-weight machines undertakes to build heavy machinery, adding powerful machine tools to its equipment for the purpose of getting out the heavier line of output. Instead of devising a proper redistribution of operating expenses, allotting the proper machine rates and departmental expense rates to the machines and departments working on the heavier line of machines, the same old expense percentage is added as was reckoned on the former general line of output, resulting in an apparent cost that will enable the company, according to these erroneous figures, greatly to underbid old established concerns building heavy machinery. At the end of a year the total expenses will be seen to have run up, and the uniform distribution of manufacturing expense will now make the standard lighter product apparently cost so much that it cannot be sold at the old prices. Prices are raised on the old line and business lost. This procedure has been gone through with in a number of instances by companies engaged in the steam-engine and the electric motor and dynamo business, with business failures as the finish of undertakings based on inaccurate costs.

Cost as a Basis of Selling Prices

In most competitive lines of business it is quite true that in the past competitors' prices have controlled selling

prices. Accurate cost systems, however, will disclose which particular items are the ones on which the largest profits are possible, for naturally the trade in these items will be the trade which the sales department will wish to develop. At the same time, the most profitable items may not be the ones which are in greatest demand. From the standpoint of sales policy we must make the most desirable goods at as low prices as our competitors do, and preferably with some features which will make them more desirable than the competitors' goods. The value of accurate costs has in the past been overlooked by many successful managers for the reason that in many cases success has been due more to fortuitous circumstances, such as natural advantages of location, transportation, and priority in the business, than to efficient business methods.

Wastes Disclosed by a Cost System

Comparative costs of the material and labor entering into the same item made at different times will reveal at all future times any overrunning of past averages. If these past averages have been supplemented by time-and-motion studies, and standard costs predetermined as a basis of current performances, it becomes possible to detect current wastes as they occur, instead of in a retrospective manner. A good system of classified standing-expense orders closed monthly and compared month by month will show also any fluctuations in the classified expenses. The study of expenses thus brought about will result in the avoidance of wastes.

Lower Production Costs Necessary

The entire history of manufacturing consists of a record of improved processes involving shorter times of

production, decreased power and supply bills, and a smaller proportion of waste. The principal factors which have been incentives to the inventor and works manager in bringing about this condition are increased competition, widening sales markets, and longer transportation distances.

About the middle of the nineteenth century, when notable improvements were made in textile machinery increasing the output per man, there was much fear that there would not be enough work to go around. In Manchester, England, mills were burned and machinery destroyed by mobs. Subsequent developments in the textile industry have proved that these fears were entirely groundless, for today's machinery produces an output per man eight times larger than was produced by the machinery of 1840, while the number of textile workers in Manchester is six times the number engaged in this field in 1840. The history of industry shows that the increased output per man, as a whole, has resulted in a greater demand for the article by reason of lessened selling prices.

Meanwhile, increased purchasing power of the community as a whole has resulted in entirely new industries, which have quickly absorbed the less capable workers temporarily out of work in certain lines of industry where improved machinery resulted in a greater output per man, and the demand did not increase immediately at a sufficient rate to justify the employment of all of the previous workers. This last-named condition is the exception, however. About the only examples of it which can be cited are those of the linotype machine in the printing trade, which took the place of the hand type-setters, and of the glass-blowing machines which are being installed in bottling works.

The profits in an industry may be increased by (1) increasing the selling prices with stationary or lowered costs of production, (2) by increase in quantity of sales with the same plant and equipment, or (3) by decreasing the cost of production under either of the first two assumptions.

Unfortunately, the tendency in some industries has been to maintain selling prices even in the face of lower costs of production. In order to secure a uniform distribution of wealth and greater general purchasing power in the nation, it is absolutely essential that lessened production costs be accompanied by lower selling prices; otherwise, the lack of uniform distribution of wealth will lead to a decreased general demand for commodities of all kinds, which demand is the basis of continued manufacturing activity.

Cost of Repair and Detailed Parts

The establishment of correct prices on repair parts and minor details is greatly facilitated by accurate cost systems. It stands to reason that a company making individual parts in quantity is in position to make a considerable profit on these individual parts, since the selling price need be only slightly less than that offered by a job shop which would have to make the parts singly and consequently at a much greater cost than the manufacturing establishment. Moreover, the manufacturing establishment making them in quantity and having them in stock can, under ordinary circumstances, make immediate delivery of all standard repair parts.

Any cost system relating to assembled products, therefore, should be built up in such a manner that the costs of individual parts are easily determined. The cost data should be indexed and classified in such a way

that quick and ready reference may be made to the data relating to any part.

Correlation of Costs to Other Manufacturing Data

The collection of the necessary statistics for records involved in conducting a cost system makes available data which are useful in guiding us in many matters of manufacturing methods and policies. From records of material costs we secure data as to the promptness with which the material specifications are furnished, the efficiency of the store-room management in replenishing depleted stocks, the promptness with which the shop can make special parts, and the accuracy with which the various parts are collected and issued for assembling and erecting purposes.

Our data in regard to labor costs furnish information as to productive capacity of various individual men and groups of men, as to the accuracy of the time-keeping department, the effect of piece-rate, bonus, and premium wage systems on shop costs.

The cost-department data with regard to manufacturing expense will disclose the economy or wastefulness of various foremen and suggest lines of investigation as to how certain expenses can be reduced.

Comparative Costs

Any complete cost system, in addition to furnishing data on work as it is completed, should supply complete information as to the comparative cost of the same process as performed on similar orders in the past. The comparative costs, together with the standard or ideal ones—which are the goal to be achieved, must be predetermined and kept prominently before all persons who are to be encouraged to achieve the desired efficiency.

Retrospective comparisons with former costs are not of much advantage. Predetermined costs, as suggested, serve a very useful purpose, however, since they establish a limit beyond which we must not go, when placed in writing prominently before the workers and foremen.

Classification of Costs

In a merchandise or trading business it is quite customary to determine the costs of buying, handling, storing, and selling the goods for any one department by means of the receipts for that department. In continuous manufacturing types, whether analytic or synthetic, such as ore mills or cement mills, it is usual to figure the costs of processing per unit of the output's bulk and compare these costs daily, weekly, and monthly. In assembling types of industries, such as the building of machinery and furniture, it is the rule to figure costs by the individual orders, which in turn are assembled costs consisting of costs of detailed parts, some of which have been made in quantity on stock orders and some of which have been made up specially for a given assembling order.

Elements of Cost

Figure 39 indicates the fundamental cost elements. Manufacturing costs constitute the first group. They consist of three elements: (a) material cost, (b) direct labor, and (c) manufacturing expense.

The first element consists of *(a) material costs.* These consist of the invoice cost of raw materials, to which is added a factor known as the "material burden," covering the cost of buying, transporting, receiving, storing, issuing, and recording materials. Frequently the material burden is added to the invoice price for a quantity of material received and divided by the quantity in order to determine the unit price for cost-finding purposes.

- Cost as a Basis of Selling Prices
  - Manufacturing Costs
    - Material Cost
      - Invoice Cost
      - Material Burden
    - Direct Labor.
    - Manufacturing Expense
      - Expense Material
      - Indirect Labor
      - Supervisional Salaries
      - Clerical Salaries in Works
      - Fixed Plant Charges
      - Variable Plant Charges
  - Selling Expense
    - Salary of Sales Manager
    - Office Expense in Selling
    - Salesmen's Salaries and Commissions
    - Advertising
    - Shipping Department
    - Selling Losses
  - Administrative Expense
    - Salaries and Expenses of General Officers
    - Office Expense
    - Deferred Charges
  - Percentage for Profit

FIG. 39.—Chart Illustrating Costs as a Basis for Selling Prices

The next element is *(b) direct labor.* This element consists of all labor expended directly upon the order in question. It does not include any indirect labor, the latter being charged to expense order numbers.

The third element is *(c) manufacturing expense.* This element consists of the following subdivisions: (c1) expense material, such as waste, machine oil, brooms, etc.; (c2) indirect labor which cannot be charged directly to a production order and is therefore charged to a certain expense order of the standing-expense order series, as explained in a later chapter; (c3) supervisional salaries of bosses, foremen, and superintendents, planning-department heads, and works manager; (c4) all clerical salaries connected with the works; (c5) all fixed charges, such as interest, depreciation, taxes, and insurance on plant; (c6) all variable plant charges, such as power, lighting, heating, plumbing repairs and maintenance, etc.

The second group of cost is *selling expense,* including salaries of sales manager; cost of clerical work; stationery and supplies in main and branch selling offices; salaries and traveling expenses of salesmen, if on a salary basis, or commission, if on a commission basis; all advertising expenses; expenses of the shipping department; and losses on customers' accounts.

The third group of cost is *administrative expense,* and includes such items as salaries and expenses of general officers, clerical help, stationery and supplies in administrative offices, deferred charges relating to organization expenses, etc., which must be distributed over several years and included in selling prices of goods, if we wish to cover actual costs.

Finally, if a cost price has been determined by the addition of all the foregoing elements, it is necessary to add

a percentage for profit, which should be not only ample to cover dividends and surplus, but should be sufficient to provide a factor of safety, so as to counterbalance errors in design or construction, defective goods, bad debts, and ordinary sources of loss suffered by every business. The amount to be added for profit is rarely less than 20 per cent above the manufacturing cost. Under ordinary circumstances it varies from 20 to 50 per cent on individual parts, with a tendency towards somewhat lower figures in the case of assembled products subject to brisk competition. It is not likely that a concern wishing to declare the dividends customary in industrial work, which are usually 7 or 8 per cent, will have an exorbitant surplus left after the addition of 20 per cent or higher on the manufacturing costs of individual parts. It must be borne in mind that manufactured stocks of parts depreciate and become obsolete, and while the depreciation factor is not so great a one as in mercantile business, it is nevertheless very important.

From the standpoint of management, it is imperative that the several elements of cost that make up the selling price should each be kept separate and distinct. The history of many industrial establishments shows that they have been exceptionally strong in one branch and inexcusably weak in another. Perhaps production was efficient, but selling was weak. Perhaps both selling and production costs were low, but the administrative costs, especially those relating to financing the business, were absurdly high and carried on under a policy likely to be ruinous to any establishment. Unless, therefore, the elements of cost are so kept that each can be made a subject of investigation, it is difficult to lay the finger on the weak spot.

Correlation of Cost Records and General Accounts

One of the aims of every modern accounting system is the merging of all cost records with the general double-entry bookkeeping system in such a manner that complete balance sheets can be presented monthly. The traditional type of cost record made no attempt to combine cost data with general accounts, except once a year at the annual inventory time. Under traditional methods, the bookkeeper, in order to determine the profit or loss in manufacturing, kept certain controlling accounts in his ledger, such as (1) materials, (2) labor, and (3) manufacturing expense. Each of these controlling accounts probably had several subsidiary accounts, particularly the manufacturing-expense account. At the close of a fiscal period the subsidiary accounts were closed into the three fundamental controlling accounts, and then an inventory was taken of (a) materials, (b) work in process, and (c) finished stock.

The manufacturing account was now written up. It was debited (a) with the value of work in process at the beginning of the fiscal year just closed, as per last inventory; (b) with the total cost of all labor which the cost department designated from month to month to the account department as being productive labor; (c) with the cost of all raw materials reported as used by the cost department's records, the material account being credited with the same amount; (d) with the total amount of manufacturing-expense account as it appeared in the accountant's ledger, no attention being paid to any figures which the cost department might have used to designate expense burden.

On the credit side of the manufacturing account was placed the cost of goods in process of manufacturing at the close of the current fiscal period.

The rest of the manufacturing account was intended to show the total expenditure by reason of manufacturing.

Modern accounting differs from the traditional type, as indicated, in that a monthly balance sheet is demanded instead of merely an annual statement. This demand requires the introduction of perpetual inventories to cover (a) material, (b) work in process, and (c) finished stock. The methods of procedure can best be illustrated by putting the discussion into ledger form as follows:

MATERIAL BURDEN

Debit

(1) With salaries of purchasing agent and all clerks in purchasing office; all stationery, supplies, traveling and other expenses in purchasing department.

(2) With salaries of manager of stores department. Salaries of all clerks in stores office or other store room; wages of all labor employed in handling and arranging storeroom material; also cost of all stationery and other expenses connected with the conducting of the stores department.

(3) With salaries of receiving clerk and assistants; wages of laborers in receiving department.

(4) With freight, express, and drayage on all materials received.

Credit

(1) With the amount of material burden added as a percentage to invoice costs of material received during the current fiscal period. At this time debit material account with a like amount.

MATERIAL ACCOUNT

Debit

(1) With the total cost plus material burden of materials on hand at the beginning of the fiscal period.

(2) With the invoice cost of all materials purchased during the fiscal period.

(3) With the amount of material burden added as a percentage to invoice costs of material received during the current fiscal period. At this time material burden is credited with a like amount.

Credit

(1) With goods applied to work in process as per records of withdrawal from stores. This procedure assumes that the balance-of-stores clerk received authorization covering everything entering into work in process.

(2) With any goods returned to suppliers.

PAY-ROLL ACCOUNT

Debit

(1) With. total amount of cash put by cashier in all pay envelopes of men working on hourly basis.

Credit

(1) With such proportion of pay-roll as is subsequently reported by cost department to represent indirect labor. Charge at this time manufacturing expense or a subsidiary account for which manufacturing expense is a controlling account with a like amount.

(2) With the amount subsequently reported by the cost department as representing direct-labor portion of the payroll. At this time debit direct-labor account with the same amount.

DIRECT-LABOR ACCOUNT

Debit

(1) With the totals of direct-labor portion of pay-rolls as represented by cost department.

Credit

(1) With the total money value of direct labor to be charged to work in process in a given fiscal period. At this time debit work in process with a similar amount.

Manufacturing Expense

As previously explained, there may be but one manufacturing-expense account to which all manufacturing expenses are charged as they occur, or manufacturing expense may be an account controlling a score or more subsidiary accounts which include manufacturing expenses. The example stated below is put into simple form, and although the items composing manufacturing expense may not include all classes, they are representative of some of the most ordinary items to be found. The ledger account given below will therefore assume that manufacturing expense is not a controlling account, but carries all classes of manufacturing expenses in the single account.

MANUFACTURING EXPENSE

Debit

(1) With the cost of all expense materials and supplies which do not enter directly into the manufactured product.

(2) With the proportion of all pay-rolls during the current fiscal period which have been designated by the cost depart-

Credit

(1) With the total of expense charged to work in process during the current fiscal period as per reports of the cost department. At this time charge work in process with a similar amount.

ment as representing indirect or expense labor. At this time credit pay-roll account with a similar amount.

(3) With all supervisional salaries of gang bosses, foremen, and superintendents. At this time credit salaries account with a similar amount.

(4) With all clerical and administrative salaries in works. At this time credit salaries account with a similar amount.

(5) If the fiscal period is monthly, with one-twelfth of the fixed plant charges. At this time credit fixed plant-charges account with a similar amount.

(6) With such proportion of variable plant charges for the current year as it has been decided shall be borne by current fiscal periods. At this time credit variable plant-charges account with a like amount.

WORK IN PROCESS

Debit

(1) With the total value of work in process on hand at the beginning of the fiscal period.

(2) With total amount of materials applied to work in process as per records of

Credit

(1) With the total manufacturing cost of all work in process completed and transformed into finished product as per records of the cost department during the current fiscal period. At this time

withdrawals from stores. At this time credit material account with a similar amount.

(3) With all direct labor reported by the cost department during the current fiscal period. At this time credit direct labor with a similar amount.

(4) With all manufacturing-expense burden added to work in process during the current fiscal period reported by the cost department. At this time credit manufacturing expense with a similar amount.

debit finished-product account with a similar amount.

FINISHED PRODUCT

Debit

(1) With the manufacturing cost of all finished product on hand at the beginning of the fiscal period..

(2) With the manufacturing cost of all work in process which has been transformed into finished product during the current fiscal period. At this time credit work in process with a similar amount.

(3) With the manufacturing cost of all returned goods.

Credit

(1) With the manufacturing cost of all finished product shipped or turned over to the sales department or branch offices during the current fiscal period.

Difference between Manufacturing Cost and Selling Cost

As previously explained under the heading "Elements of Cost," the total cost will vary from manufacturing

costs by including further factors covering selling expenses, administrative expenses, and a percentage for profit. Some manufacturing establishments prefer to add a slight factor of safety over and above manufacturing expense so as to allow for fluctuations in cost, billing the goods to the sales department at a slightly higher price than the total manufacturing cost. In order to allow for fluctuation in cost, any apparent profits made by the shop can be transferred to reserves for meeting depreciation of plant and equipment.

TEST QUESTIONS

1. What are the principal purposes served by the old-fashioned or traditional cost system?
2. What are the reasons for inaccurate costs?
3. Why are accurate costs essential to business success?
4. How may the cost system be made to disclose wastes?
5. In what different ways may the profits of an industry be increased?
6. In a business making assembled product what is the argument in favor of collecting costs of individual parts?
7. In what way may the cost system be made to reveal the economy or wastefulness of various foremen?
8. What are predetermined costs and what purpose may they be made to serve?
9. Under what conditions is the process method of determining costs preferable to the product order or business cost method?
10. Draw a chart indicating the fundamental cost elements which go to make the total cost of any kind of product.
11. Define the following: (a) material burden, (b) direct labor, (c) expense material, (d) indirect labor, (e) supervisional salaries, (f) fixed charges, (g) variable plant charges.
12. What items constitute selling expense?

13. What are the chief items which go to make up administrative expenses?

14. What is the argument in favor of merging summarized cost records with the general accounts of the business?

15. Give the ordinary debits and credits to material-burden account.

16. Give the ordinary debits and credits to material account.

17. Give the ordinary debits and credits to pay-roll account.

18. Give the ordinary debits and credits to direct-labor account.

19. Give the ordinary debits and credits to manufacturing-expense account.

20. Give the ordinary debits and credits to work-in-process account.

21. Give the ordinary debits and credits to finished-product account.

22. Explain the difference between manufacturing cost and selling cost.

CHAPTER IX

METHODS OF COLLECTING MATERIAL AND LABOR COSTS

SOURCES OF COST DATA

The diagram in Figure 40 indicates the five principal sources of cost data. These data relate to (1) orders, (2) materials, (3) material burden, (4) direct labor, (5) manufacturing expense.

DATA REGARDING ORDERS

The cost department needs to have for its own files an exact copy of all orders issued by (a) the shipping or order department as a result of instructions from the sales department authorizing the shipment of completed product in parts in stock, or the making to order of product, or the repair of parts or completed product; (b) the production department, whether stock orders for detail part replenishment, orders for assembling groups or entirely erected product, or special repair part or repair orders.

It frequently happens that the serial numbering scheme of the commercial order department may be quite different from that employed by the production department, since the order department's system will be adapted to ease of reference from the standpoint of selling and commercial records, whereas, the production department's numbering system will be adapted to ease of reference and natural classification of product in the shop.

Data to be Furnished to Cost Department

Group I Orders	From shipping or order department	Copies of all shipping orders and contracts to ship
	From production department	Copies of all shop stock orders for detail part replenishment Orders for assembling groups or entirely erected product, special repair part, or repair orders
Group II Materials	From bill of material department	All material specifications
	From stores manager	All withdrawal orders on store-room
	From receiving department	Copies of all lists of materials received
	From purchasing agent	Copies of all invoices or prompt advices as to quantities and prices of all goods purchased
Group III Material Burden	From accounting department	Totals of inward freight and hauling Totals of purchasing department, receiving department, and stores department salaries and wages as well as cost of supplies, traveling, and other expenses in these departments
Group IV Direct Labor	From employment department	Names of all persons employed, together with check numbers, rate of pay, and exact date of employment of each Names of all persons quitting, together with exact date of quitting and check number
	From time-keepers	Exact time put in on each productive or expense order by each employe Distribution of each man's work during every pay period, such distribution being checked against pay-roll, time, and money amount
	From cashier	Copies of all pay-rolls
Group V Manufacturing Expense	From accounting department	All administrative and clerical salaries All supervisional shop salaries All fixed charges, such as interest, depreciation, taxes, insurance, etc.
	From cost department's system of standing orders	Expense material, such as waste, machine oil, etc. Indirect labor charged to standing expense orders Variable plant charges covering power, lighting, heating, plumbing, repairs, maintenance, etc.

FIG. 40.—Chart Illustrating Sources of Cost Data

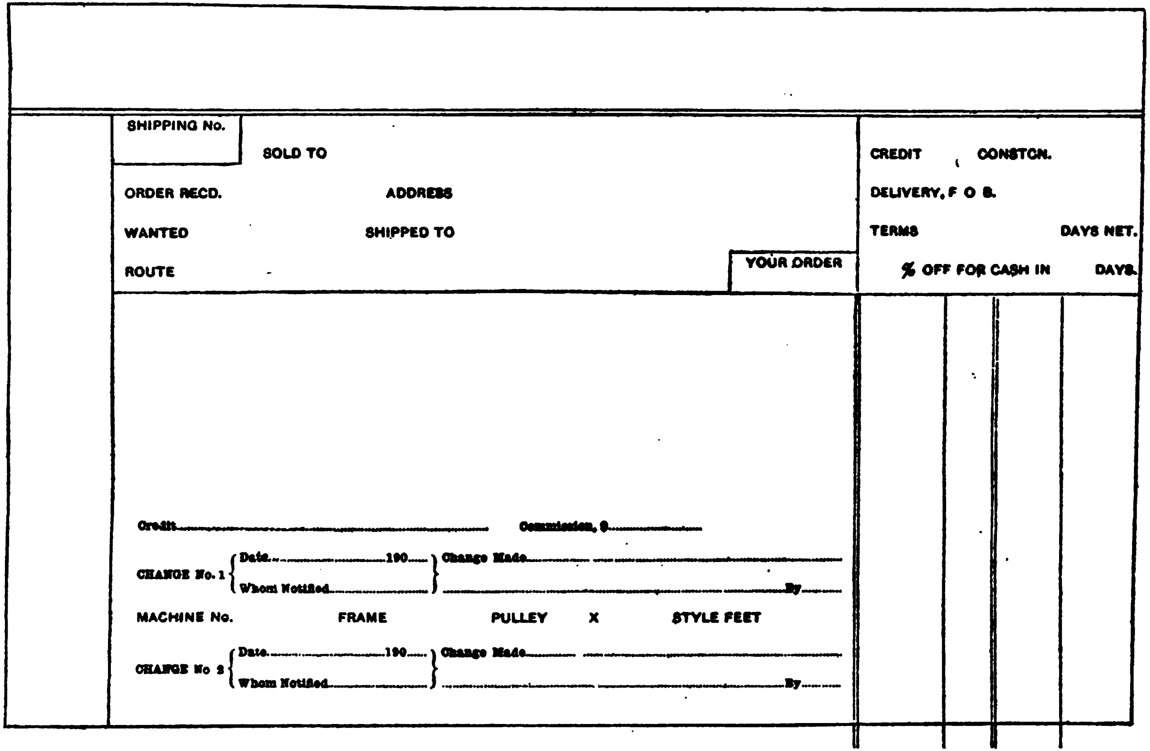
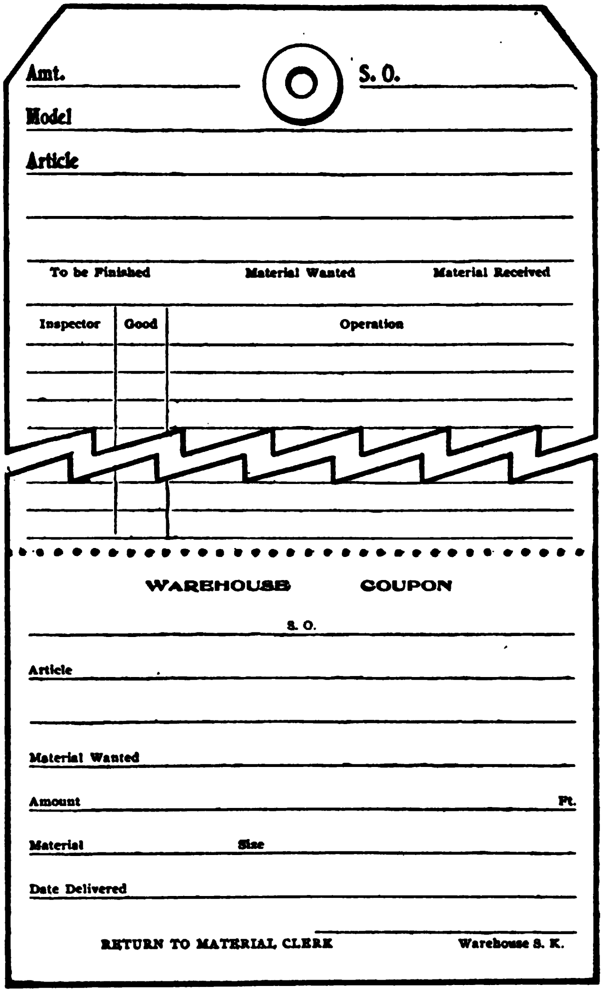

SHIPPING No.
SOLD TO
ORDER RECD.
ADDRESS
WANTED
SHIPPED TO
ROUTE
YOUR ORDER
CREDIT CONSTCN.
DELIVERY, F O B.
TERMS DAYS NET.
% OFF FOR CASH IN DAYS.
Credit.. Commission, $....................
CHANGE No. 1 { Date..........................190..... } Change Made..
Whom Notified.......................... ....By..........
MACHINE No. FRAME PULLEY X STYLE FEET
CHANGE No 2 { Date..........................190..... } Change Made..
Whom Notified.......................... ....By..........

FIG. 41.—Typical Commercial Order Department Copy of Sales Order, of which a Manifold Copy is Furnished the Cost Department

The commercial order department will probably classify its orders into series. For instance, orders designated by the prefix "C" followed by the number would



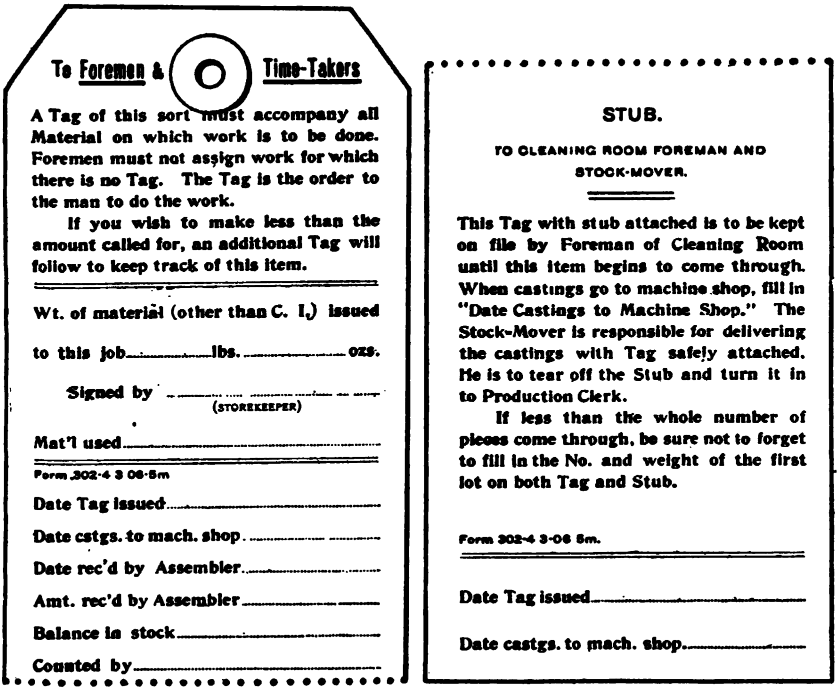
Amt.
S. O.
Model
Article
To be Finished
Material Wanted
Material Received

Inspector	Good	Operation

WAREHOUSE COUPON
S. O.
Article
Material Wanted
Amount Ft.
Material Size
Date Delivered
RETURN TO MATERIAL CLERK
Warehouse S. K.

FIG. 42.—Front of Tag Type of Production Order
For reverse, see Fig. 43.

be contract orders; orders designated by "R" followed by a number would be repair orders; orders designated by "D" followed by a number would be detail orders. Such detail orders might carry sub-order numbers assigned by the order department; for example, a "D"


To Foreman & Time-Takers

A Tag of this sort must accompany all Material on which work is to be done. Foremen must not assign work for which there is no Tag. The Tag is the order to the man to do the work.

If you wish to make less than the amount called for, an additional Tag will follow to keep track of this item.

Wt. of material (other than C. I.) issued

to this job.................lbs..................ozs.

Signed by ....
(STOREKEEPER)

Mat'l used..............................

Form 302-4 3 08-5m

Date Tag issued..............................

Date cstgs. to mach. shop..............................

Date rec'd by Assembler..............................

Amt. rec'd by Assembler..............................

Balance in stock..............................

Counted by..............................

STUB.

TO CLEANING ROOM FOREMAN AND STOCK-MOVER.

This Tag with stub attached is to be kept on file by Foreman of Cleaning Room until this item begins to come through. When castings go to machine shop, fill in "Date Castings to Machine Shop." The Stock-Mover is responsible for delivering the castings with Tag safely attached. He is to tear off the Stub and turn it in to Production Clerk.

If less than the whole number of pieces come through, be sure not to forget to fill in the No. and weight of the first lot on both Tag and Stub.

Form 302-4 3-08 5m.

Date Tag issued..............................

Date castgs. to mach. shop..............................

FIG. 43.—Reverse of Tag Type of Production Order Shown in Fig. 42

order number might be followed by a prefix "S" followed by a sub-order number to indicate detail parts to be shipped from stock, or the detail order number might be followed by the letter "P" followed by a sub-order number to indicate that a production order had been issued by the shop to make some of the items for the detail order.

The orders written by the order department are usually manifolded on a billing machine. The different series are usually written on different shades of colored paper. Figure 41 illustrates a type of order as issued by the commercial order department. It will be noticed that orders of this sort contain commercial and financial information which, while necessary as a matter of record, is not essential information for the production or planning departments.

The orders written by the production or planning departments more often take the form of follower tags to accompany the work in process through the shop. Figure 42 illustrates the front and Figure 43 the reverse of a tag of this sort. Manifold copies of the tags are filed in the production-order office.

DATA REGARDING MATERIALS

In order that the cost department may have a record of the total charges to material account, it is necessary that a copy of the receiving department's report of materials received be sent to the cost department. Figure 44 illustrates a typical receiving-department report. A different type of report of materials received is illustrated in the chapter on stores. In order that the materials may be correctly priced, the cost department should receive either the original invoice from the purchasing agent or copies of the same. In case the original invoices are sent to the cost department, the routine of handling them must be arranged in such a manner that they are not delayed at all.

In order that the cost department may credit material account with the proper amount for all materials withdrawn from store room, it is necessary that copies of all material specifications be sent to the cost department.

It is also necessary that all withdrawal orders on the store room, as well as any credit slips for returned materials (as soon as they are entered on the perpetual inventory record by the balance-of-stores clerk), be sent to the cost department.

DATA REGARDING MATERIAL BURDEN

In order that the cost department may establish the material burden properly, it is necessary that the ac-

MATERIALS RECEIVED

Page No.______ Report No.______

Date______

Consignor	Date Shipped	Purchase Order No.	Articles	Quantity

FIG. 44.—Receiving-Department Report of Materials Received, a Manifold Copy of Which Goes to Cost Department

counting department furnish all information as to inward freight and hauling, totals of purchasing department, receiving department, and stores department salaries and wages, as well as cost of supplies, traveling and other expenses in these departments.

DATA REGARDING DIRECT LABOR

In order that the cost department may charge to work in process or manufacturing expense, as the case may

Week ending..............................

No.
Name.

DAY		IN	LOST OR OVERTIME		OUT	
			OUT	IN		
S	A. M.					
	P. M.					
M	A. M.					
	P. M.					
T	A. M.					
	P. M.					
W	A. M.					
	P. M.					
T	A. M.					
	P. M					
F	A. M.					
	P. M.					
S	A. M.					
	P. M.					

Total time ....***hrs.***

Rate ....

Total wages for week **$**....................

FIG. 45.—Clock Stamp Time Card Registering Arriving and Leaving Time of Employes

The totals on these cards must check with the totals on individual-job cards shown in Fig. 46.

be, the correct amount of labor at the correct rate, it is necessary that the employment department furnish the cost department the names of all persons employed, together with check number, rate of pay, and the exact date of employment of each; also a list of all persons quitting, together with the exact date of quitting and the check number.

From the time-keeping department the cost department will receive data showing the exact time put in on each productive or expense order by each employe. Figures 45 and 46 are examples of time cards. Figure 45 is used for registering only the arriving and leaving time of employes and is used primarily for pay-roll purposes. Figure 46 is a job time card, sometimes called a "work card," on which is listed the time charged to a given productive or expense order.

Most modern systems for keeping record of time spent on various jobs provide a separate slip for each job. When this arrangement is used the separate slips can be filed either back of guide cards or in envelopes, thus doing away with the need of transferring postings from a general time card to the various cost records. With a well-ordered planning department the time slips or work orders are written out in advance, everything being filled in excepting the check number of the worker and the time of starting and finishing.

It is important that the money value of time postings against various productive and manufacturing expense orders in a good pay period foot up to exactly the same amount in dollars and cents as the total pay-roll for that period. In connection with this checking it is quite customary to prepare for each shop department a so-called "distribution-of-labor sheet" for every pay period. On this distribution-of-labor sheet appears the time of

IN	OUT	Elapsed Time

Oper. No.	Oper. Name
Article	
F. O. No.	Draw. No.
D. W. Rate	Machine No.
P. W. Price	Amt. Finished
Prem. All'ce	Amt Del. Previous
Amt. to Pay	Total Finished
Emp. No.	
Emp. Name	
Job Card No.	

FIG. 46.—Clock Stamp Job Card Registering the Time Charged to a Given Production or Expense Order

The totals on these cards in a given pay-period must check with totals on payroll cards shown in Fig. 45.

each employe in the department, together with a classification of the time as well as the money which will be paid to him.

The total postings of labor expressed in money value on cost records in a given pay period must be the same as the total of the pay-roll distribution. In order to effect this balance, the entries covering the cost of fractional hours will have to be increased or decreased by a cent or two here and there. The only way to make such an adjustment is to have the distribution of labor specify the order numbers in the cost department against which each man's time has been charged. These postings are listed on the adding machine, and if they total more or less than the man's pay envelope money, adjustment entries are made until the amounts agree. The cashier's department should furnish the cost department with copies of all pay-rolls in order that this checking may be done.

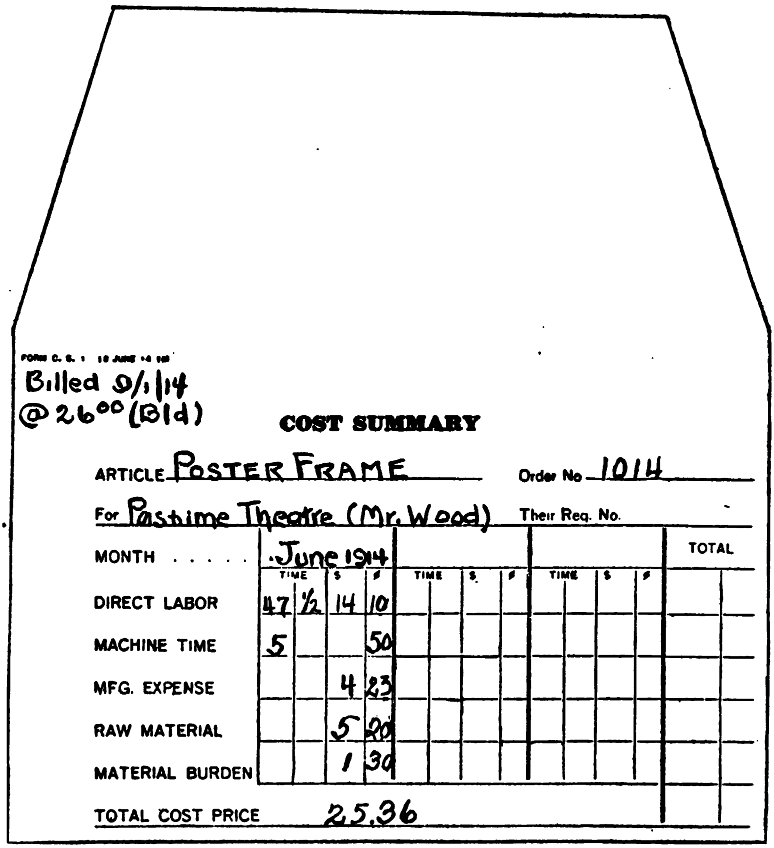
DATA REGARDING MANUFACTURING EXPENSE

In order that the cost department may establish a correct expense burden, the accounting department should furnish complete data in regard to all administrative and clerical salaries, all supervisional shop salaries, all fixed charges, such as interest, depreciation, taxes, insurance, and all special manufacturing expenses, such as legal and patent expenses. The cost department must secure, through its own system of standing orders covering shop expenses, the money value during a given fiscal period for expense material, such as waste, machine oil, etc., indirect labor charged to standing shop expense orders, all variable plant charges covering such items as power, lighting, heating, plumbing, repairs, maintenance, etc. The next chapter will outline the various methods em-

ployed in determining and distributing the expense burden.

Assembling the Cost Data

Figure 47 illustrates a stiff manila envelope arranged for filing in a standard card-index drawer, the envelope being designed to hold material withdrawal slips and



FORM C. S. 1

Billed 9/1/14
@ 26^{00} (Bid)

COST SUMMARY

ARTICLE Poster Frame Order No 1014

For Pastime Theatre (Mr. Wood) Their Req. No.

MONTH	June 1914												TOTAL	
	TIME		$	¢	TIME		$	¢	TIME		$	¢		
DIRECT LABOR	47	½	14	10										
MACHINE TIME	5			50										
MFG. EXPENSE			4	23										
RAW MATERIAL			5	20										
MATERIAL BURDEN			1	30										
TOTAL COST PRICE	25.36													

Fig. 47.—Stiff Manila Envelope to Contain Material Slips and Job Time Cards Arranged for Monthly Balance Sheet

time slips for shop orders. The printing and columns on the face of the envelope are designed to facilitate the monthly closing of accounts as well as to serve the purpose of condensed cost analysis. These envelopes may vary in capacity from an ordinary flat envelope designed

DETAIL COST CARD

S.O. | Quantity | Guide No.

Date	Operation	Wkm.	Hrs.		Rate	Labor		No. Fin	Prm Time
Name									
Size									
Class									
	Total Labor.								
	Mfg. Ex.								
	Material.								
	Total.								

FIG. 48.—Typical Traditional Cost Posting Card Necessitating Transfer of Time Postings from Job Slips by Clerks

This type is being largely superseded by the type shown in Fig. 47.

to hold a dozen or more papers, to the accordion-plaited type of envelope designed to hold bunches of slips, running from 1 to 10 inches in thickness.

The envelope type of filing time and material records is gaining in favor, because it eliminates a large amount

COMPARATIVE TOTAL COST OF DYNAMOS AND MOTORS

Capacity ---------- Voltage -------------- Style --------------------

Order No.	No. Built	Date Fin'd	Yokes	Base	Pole Pcs.	Spider	Fields	Commu-tators	Armat' Winding	Erect-ing	Paint-ing	Testing

FIG. 49.—Form for Comparing Total Costs of Assembled Product

of copying and posting. The traditional method is to post all labor costs from time cards or job slips to larger slips arranged by order numbers, a separate sheet or card being used for each separate piece on a given shop order. Figure 48 illustrates a typical labor cost card of this sort.

Comparative Costs

Comparative costs are of three kinds: (1) Comparative total costs of completely assembled product; (2) comparative total costs of individual parts; (3) comparative operation costs.

In order to prepare a record of comparative total costs of assembled product it is necessary only to prepare a card index or loose-leaf binder in which are recorded the chief groups which constitute a total cost. Figure 49 illustrates a form for recording comparative total cost of dynamos and motors. A study of these comparative total costs is necessary when the management contemplates placing new designs on the market and is comparing probable cost factors in connection with the new line with those recorded for the existing styles. The comparative total costs are also valuable for the works manager in noting any fluctuations in the leading factors and in demonstrating to him the benefits accomplished by improved methods.

Figure 50 illustrates a comparative total-cost record of individual parts. This comparative cost record serves as a basis for preparing price-lists of repair parts and also in noting the results of improved shop methods as affecting costs.

Figure 51 is a comparative operation-cost record. The entries on this record show the relative cost of the leading operations performed by various workmen or groups of

workmen, and serve as an aid in determining the standing of employes, as well as in the establishment of bonus or premium incentives, either for the operations in question or for new similar operations.

COMPARATIVE PIECE COST RECORD

DRAWING PART NO.

Order No.	Date	Quantity	Labor	Material	Expense	Cost Ea.	Average Cost	

FIG. 50.—Comparative Individual-Part Cost Record

COMPARATIVE OPERATION COST RECORD Part No. 705

Type of Machine R.D.3 H.P. 1250 rev. 500 volt. Sheet No. 1

Part Armature Winding per Winding Spec. #562

Other Data 36 Slots 72 coils 12 turns ea. #19 d.c.c.

Order No.	OPERATION COSTS									
	First Winding					Second Connecting				
	Man's No.	Time Taken	Flat Cost	Bonus	Total Cost	Man's No.	Time Taken	Flat Cost	Bonus	Total Cost
15531	69	9	2.70	15	2.85	65	1/2	15	08	23
15532	69	7	2.10	45	2.55	65	3/4	23	04	27
15533	73	9	2.70	15	2.85	67	1-1/4	38	00	38
15534	73	8	2.40	30	2.70	67	1	30	00	30

FIG. 51.—Comparative Operative Cost Record

The comparative operation cost record cannot in any way take the place of a scientific time and motion study. The latter must always be the basis of the time feature

in connection with the accomplishment of shop operations. Our comparative operation cost record, however, introduces a new feature not disclosed by the time and motion studies, namely, the rate of pay and total amount of bonus, which vary with different employes.

Periodic Reports by the Cost Department

The calendar month, as a rule, does not constitute so well-balanced a fiscal period as one of four weeks, since the calendar month would sometimes include four pay-rolls and sometimes five. In order to assist in adapting the fiscal periods to pay-roll periods, it is customary in a good many lines of business, which have undertaken the preparation of fiscal reports every four weeks, to change all salaries from a monthly to a weekly basis. The reports for each fiscal period should cover:

1. Value of material received at the close of period.
2. Value of material received during this period.
3. Value of work in process in shop at the end of period.
4. Total of all charges to work in process during this period.
5. Value of finished stock on hand at the close of period.
6. Total of all stock finished during this period.
7. Value of direct labor during this period.
8. Value of indirect labor during this period.
9. Value of all manufacturing expenses during this period.

The foregoing reports should be listed on sheets in such a way that the figures can be easily compared with figures covering the same items during previous fiscal periods and for the corresponding fiscal period in previous years.

Supplementary Reports

The principal supplementary report of the cost department will be that in which the subdivisions of the manufacturing expense account are classified. This is explained in detail in the next chapter.

Another type of supplementary reports delegated to the cost department includes efficiency records. These efficiency records consist of (a) the records of individual workmen showing each man's percentage of efficiency as compared with an established standard for each job on which he has worked during a given period; (b) departmental efficiency records in which output, number of employes, pay-rolls, and costs are compared by departments; (c) estimated value of outstanding purchase requisitions for material during this period.

In some organizations the efficiency reports are made up in a labor bureau, and the value of outstanding material requisitions are turned in by the purchasing department instead of the cost department.

TEST QUESTIONS

1. What are the five principal sources of cost data?
2. What data relating to orders does the cost department need to have?
3. What sort of data regarding materials does the cost department need to have?
4. What data in regard to material burden does the cost department need to have?
5. How are data in regard to direct labor collected and posted?
6. How may the labor postings on cost records be checked against pay-rolls?

7. Describe the standing order system of securing information in regard to manufacturing expenses.

8. From what sources other than standing order system are data relating to manufacturing expense gathered?

9. What methods are used for assembling the material, labor, and expense data relating to a given order or process?

10. What are the three classes of comparative costs?

11. What method is used for tabulating each of the above?

12. What sort of summarized reports relative to material should the cost department make?

13. What summarized information should the cost department report as regards work in process?

14. What sort of summarized reports relative to finished parts or finished stock should be made?

15. What sort of summarized reports relative to labor should the cost department prepare?

16. What sort of reports relative to expenses should the cost department make?

17. What sort of individual efficiency records can be prepared by the cost department?

18. What sort of departmental records can be prepared by the cost department?

19. Draw a chart showing the principal departments from which the cost department obtains data, indicating very briefly the kind of data obtained.

20. What kind of work in the cost department requires ability as a detailist, and what kind of work demands ability to generalize?

CHAPTER X

THE DISTRIBUTION OF THE EXPENSE BURDEN

The General Divisions of Expense

There are three general groups of expenses, namely, (1) administrative expenses; (2) manufacturing expenses; (3) selling expenses. We should remember that administrative expenses are a general charge upon the business as a whole, while manufacturing expenses and selling expenses are peculiar to the two activities of producing and selling. Furthermore, it is desirable to distinguish clearly between manufacturing costs and selling costs in order that changes either in manufacturing or in selling conditions may be properly registered. The production division should not be held accountable for unusual selling expenses, and vice versa. This treatise is not concerned with the detailed operations of selling expense.

ADMINISTRATIVE EXPENSES

Administrative expenses include organization expenses, such as promoter's and legal fees. The legal fees in this group will exclude such as are connected with patents and compensation matters, which are manifestly manufacturing expenses.

Administrative expenses will include also the pay and expenses of directors, salaries of officers, general accountants, clerks in general office, depreciation of

general office equipment, expenses in the way of stationery, postage, and supplies in general office, and wages of janitors and other laborers doing work in connection with the general office.

In order to show administrative expenses as a cost factor they are usually proportioned to manufacturing and selling costs. For example, if the total manufacturing cost of all product in a year, exclusive of administrative and selling expenses, aggregates $1,000,000, and if administrative expenses were $100,000 and selling expenses $100,000, we should add 10 per cent to the total manufacturing cost as the cost to sales department, and 10 per cent to selling costs, so as to secure the net total costs, including selling and administration.

It is customary and rational to allot administrative expenses in this manner as a percentage on the money value of product. It is worth mentioning, however, that other methods have been proposed. For example, in establishments where all other expenses are allotted to the unit of product, as per ton of output, administrative expense can be easily allotted on the same basis. In public-school systems and in colleges, an allotment on the basis of expense per school-child or per student-hour may be made. In railroads the allotment can be made on a basis of the ton-mile or the passenger-mile.

MANUFACTURING EXPENSES

Having segregated the material cost and direct labor cost from the manufacturing cost totals, there remain various methods of allotting, distributing, or distributing the manufacturing expense burden or overhead. This allotment is made in one of the four following manners: (1) allotment by product; (2) allotment by labor; (3) allotment by machines; (4) combinations of the preceding three methods.

Allotment by Product

The simplest method of allotment by product is by bulk in a continuous process analytical manufacturing establishment, as in the case of the making of mineral or vegetable oils. A single rate will suffice, if the product and process are fairly uniform. However, as soon as we have different classes of product with different processes, it becomes necessary to divide the manufacturing expenses into two general groups, the first one including expenses common to all product and to all processes, and the second including expenses peculiar to certain classes of product, thus making two rates, a general rate per gallon or barrel for all oils in the case of oils, and a class rate per gallon or barrel to be added to each class, distinct from the general rate.

Instead of the allotment by bulk we usually have an allotment by weight, as in foundries and rolling-mills. Here again we shall have different classes of castings. All of the castings must bear a certain assessment per pound for the expenses common to all castings. On the other hand, there will be a class rate per pound to cover such expenses as are peculiar to each class of castings and not general.

Another method of allotting expenses by product is to assess the expense as a percentage on the cost of material. Where the material is uniform this method answers practically the same purposes as an allotment per unit of finished product. Where the material varies in cost, however, this method cannot be applied. For instance, it is manifestly erroneous to charge an article made out of brass with seven or eight times the burden charged on an article made out of iron in the same plant, simply because the raw material in the brass article costs seven

or eight times what the raw material in the iron article does.

Allotment by Labor

Probably the most widely used method of assessing the manufacturing expense is by allotting it in accordance with the direct labor factor in production. There are two methods of allotting by direct labor: (1) the percentage on direct labor method; (2) the hourly manufacturing expense rate, in accordance with which for every hour of direct labor charge there is an hour of manufacturing-expense charge.

THE PERCENTAGE-ON-DIRECT-LABOR METHOD

In this method we keep accurate record of the flat cost of all wages charged directly against production, such charges including only labor going directly and physically into specifically recognizable production goods. All other labor finds its way through various subsidiary accounts ultimately into the manufacturing expense account.

At the close of a fiscal period or at the close of a predetermined series of fiscal periods, the money total of the direct-labor costs for the time in question is compared with the money total of the general manufacturing expenses of all sorts, including all indirect and non-productive labor charges. Taking the total direct-labor costs as representing 100 per cent, we determine what percentage of this amount is represented by the money total of the manufacturing expenses. For instance, if the direct labor costs in the period were $100,000 and the manufacturing expenses during the same period were $150,000, then we call the direct labor costs 100 per cent and we find that the manufacturing expenses were 150 per cent. We therefore decide to assess 150 per cent of

the direct labor cost of every piece or assembled group or completed product to the combined cost of labor and material so as to arrive at the total manufacturing cost.

For example, our cost records might show that a spur gear costs us 20 hours of direct labor at 30 cents an hour, making a total direct-labor cost of $6.00. Our manufacturing expense burden would be 150 per cent of $6.00, or $9.00, making the combined cost of direct labor and manufacturing expense $15.00. If the material cost $1.00, we should add it at cost, provided our manufacturing-expense account included material-burden charges. The total manufacturing cost of our spur gear would then be:

Material	$1.00
Direct Labor	6.00
Manufacturing Expense	9.00
Total	$16.00

In case material burden was kept separate and not included in the general manufacturing expense account, and not added to material prices when material was credited to stores and charged to work in process, we shall have to add a percentage on material cost to cover material burden. This percentage may be from 10 to 30 per cent of the invoice costs of material.

The percentage-on-direct-labor method is today the most usual one of assessing the manufacturing expense burden. The argument in its favor is that it is the simplest of all systems to apply and the easiest one to figure. Opposed to this argument are certain manifest defects. If the rate of pay for the same kind of work varies, we are not only paying a higher-priced man more money for doing the work, but we are assessing a higher share of the manufacturing-expense burden to the job he did than if a lower-priced man did the work. If the

lower-priced man took twice as long to do the work, then the job had the benefit of the floor space, the power, light, heat, mechanical transportation, supervision, and indirect labor factors of the shop for twice as long a period as the same job did when done by the higher-paid man.

Our percentage-on-direct-labor method takes no notice of the time element in direct-labor costs. Where the product is fairly uniform and the same rate of pay prevails for the same class of labor and the time in which each job is done does not fluctuate much, this defect may be overlooked. However, such conditions rarely exist. Hence, the tendency among progressive manufacturers is to abandon the percentage-on-direct-labor method and substitute for it the hourly manufacturing expense rate.

THE HOURLY EXPENSE RATE

In this method we keep an accurate record not only of the total flat cost of all wages charged directly against production, but also of the total time of all this direct labor. As in the percentage-on-direct-labor method, all other labor finds its way ultimately into the manufacturing-expense account. At the close of a fiscal period or a series of fiscal periods, the total hours spent in direct labor during the time in question is calculated. The manufacturing expense for the same time is divided by the total hours of direct labor. The quotient gives an hourly expense rate for every hour of direct labor.

In favor of this plan it is argued that rent, taxes, depreciation, and all other fixed as well as variable plant charges vary directly with the time element. Under this system a job which consumes ten hours of direct labor in the shop is charged with twice the manufacturing

expense of a job which consumes five hours of direct labor in the shop. If, for example, the direct labor costs in a period are $100,000 and represented 400,000 hours, and the manufacturing expenses during the same period were $150,000, we divide the $150,000 by 400,000, giving us 37½ cents an hour as the hourly manufacturing expense rate. Taking now the spur gear which cost us 20 hours of direct labor at 30 cents an hour, making a total direct labor cost of $6.00, we should add 20 hours of manufacturing expense at 37½ cents an hour, making $7.50 as the expense burden. If, however, the direct labor cost of $6.00 had represented 30 hours at 20 cents an hour, we should add 30 hours of manufacturing expense at 37½ cents an hour, making $11.25 as the expense burden. Under the percentage-on-direct-labor system, the expense burden would have been the same in each instance.

When we compare the widely differing results under the two different systems, we begin to realize that, while accounting accuracy is absolutely essential, it is not accuracy in postings alone that will result in true costs. The National Machine Tool Builders' Association has adopted the hourly expense rate for the sake of uniformity, as well as for its apparently greater accuracy in manufacturing lines of the synthetic or assembling type.

Local and General Burden Rates

No matter which of the former methods is used, there is one argument which will have to be met, namely: If we manufacture a wider line than our competitors, have we allotted our expense burden so as to charge it against the various departments fairly? If we manufacture two lines, one requiring only light machinery and much

bench work, and the other, heavy machinery and little bench work, is it fair to charge the first line with the same manufacturing expense burden rate as we charge to the second? Does this procedure not make the first line apparently cost us too much and the second line cost us too little? If so, how can we remedy the defect?

This argument has been met by segregating all manufacturing expense items common to all departments from those local to specific departments, establishing first a general expense rate common to all departments and next local expense rates for certain departments or groups of departments. Such a division would relieve all bench and vise work from any overhead involving operation of machines, and would separate a light machine shop from a heavy machine shop. This division is easily provided for on the hourly basis by dividing the direct-labor total for a given fiscal period into its group-constituents. For example, suppose we had the following group-constituents:

Direct-Labor Costs		Direct-Labor Hours
Small-machine shop	$ 50,000	200,000
Heavy-machine shop	25,000	100,000
Vise and floor work	25,000	100,000
Total	$100,000	400,000

Manufacturing-Expense Distribution

General overhead	$ 65,000
Small-machine shop	25,000
Heavy-machine shop	50,000
Vise and floor work	10,000
Total	$150,000

We should now divide our general overhead of $65,000 by the 400,000 of total direct labor hours, obtaining a

general overhead burden of 16¼ cents an hour. We should divide our small machine shop expense of $25,000 by 200,000 of total direct labor hours worked in the small machine shop, giving a local burden rate for the small machine shop of 12½ cents an hour. We should divide our heavy machine shop expense of $50,000 by 100,000 of total direct labor hours worked in the heavy machine shop, giving a local burden rate for the heavy machine shop of 50 cents an hour. We should next divide our $10,000 of vise and floor expense by 100,000 direct labor hours worked in vise and floor departments, giving a burden rate of 10 cents an hour as the local burden in vise and floor departments. The following would now be the hourly local rates:

In small-machine shop, 12½ cents
In heavy-machine shop, 50 cents
In vise and floor shops, 10 cents

In addition to the above, there is a general overhead hourly expense of 16¼ cents per hour, making the total burden rate to be charged in each group:

Small-machine shop, 28¾ cents
Heavy-machine shop, 66¼ cents
Vise and floor shops, 26¼ cents

It is quite evident that, if we figure our costs on the above basis, we may cover a wide line of work, and our costs will enable us to figure on the same basis as the man who does not cover so wide a line. Where light and heavy product is built in the same shop, the above method is absolutely indispensable, especially if there is any competition in light repair parts (and possibly the lighter assembled product) with local job shops or smaller competitors.

Allotment by Machines

The allotment of the manufacturing expense to various machines is a practice which has existed in a rather unscientific form for many years in planing-mills and in job machine shops. The method in these establishments is what has been designated as the old type of machine rate. According to it we apportion the entire manufacturing expense to machines only. For example, assuming that we have a total manufacturing expense of $150,000, we should get an approximation of the total number of hours that all of the machines of any one type and class were running, and allot to each of these groups of machines a portion of the manufacturing expense which the machines must earn, as it were, by being paid an hourly rate for their time. This old type of machine rate does not establish local or general burden rates distinct from the machine rates, but makes the machine rate carry the entire manufacturing expense burden.

The more modern machine rate is one which allots a budget to each machine or group of similar machines, such budget covering the portion of manufacturing expenses as is chargeable only to different machines or group of machines. This will naturally leave a portion of the manufacturing expense not chargeable to machines to be covered by additional burden rates. The additional burden rate may be (1) a general overhead rate only; (2) both a local departmental and a general overhead rate. The last-named method is unquestionably the more accurate and satisfactory apportioning of the manufacturing expense.

DETERMINING THE MACHINE RATES

The first step toward determining the machine rates is to separate from the manufacturing expense account

total such portion of it as exists by reason of the ownership and operation of machinery. This portion will include a share of the charges for depreciation of buildings, taxes, and insurance based on the space occupied by machines, all of the charges for depreciation of machinery, such portion of the small tools account as represents tools used on machines, such proportion of power charges as represents power needed for driving machines, and in fact everything in the way of expenses incurred by reason of operating the machinery.

Having determined what total portion of the manufacturing expense must be borne by all of the machines, the next problem is the allotment of a budget to each machine, which it must earn, as it were, by charging an hourly rate for its services. To determine this budget we need to know the approximate power-consumption of each machine, the rapidity with which it wears out small tools, and the number of total hours in a given fiscal period that each machine was operated.

Having allotted to each machine the budget which it must earn, we divide the amount of this budget by the hours the machine was operated in a similar fiscal period, so as to obtain the hourly machine rate. We now write out a card or loose-leaf binder sheet for each machine, and as we charge up machine rates to work in process, we credit the machine on its card or sheet with such earnings. At the end of a fiscal period we balance the earnings against the budget. If the earnings have fallen short, we may have to increase the rate for the next period. If they have been in excess of the budget, we may be able to decrease the rate somewhat.

The local and general burden rates exclusive of machine rates are determined by allotting the residue of the manufacturing expense account after we have taken out

the amount we expect the machines to earn, in accordance with the methods described on page 156.

The Standing Expense Orders

In order to take care of the proper collection and distribution of the expense burden, it is desirable to assign a capable man to this work as his regular duty. If the establishment has more than a hundred employes, this work will take nearly all of one man's time. If there are two hundred employes, it will unquestionably take all of one man's time in an assembling type of industry. The method used for collecting the manufacturing, selling, and administrative expense data is most generally that of classifying the various kinds of expenses in each group and assigning a number or symbol to each kind. The symbol and number used together will be found more advantageous than a numerical system, since the symbol letter followed by numbers is more flexible and permits of the addition of new standing orders without disarranging the existing list.

Typical Standing Orders in the Administrative-Expense Group

As an example of the standing orders in this group the following may be cited:

EA1—Promoter's fees.
EA2—Legal fees.
EA3—Pay and expenses of directors.
EA4—Salaries of general officers and assistants.
EA5—Salaries of general accountants, assistants, and clerks.
EA6—Depreciation of general-office equipment.
EA7—Salaries of general-office stenographers.
EA8—General-office stationery, postage, and supplies.
EA9—Wages of janitors and gardeners.
Etc.

Typical Standing Orders in the Manufacturing-Expense Group

The list suggested below indicates the nature of the groups under manufacturing expense, which will classify expenses making up the general overhead burden:

EMG1—Salaries of works manager and assistant works manager.
EMG2—Depreciation of works office equipment.
EMG3—Salaries of planning-department heads and assistants.
EMG4—Salaries of planning-department clerks and stenographers.
EMG5—Depreciation of planning-department equipment.
EMG6—Planning-department stationery, postage, and supplies.
EMGP1—Power-house labor.
EMGP2—Power-house supplies.

Coming next to the group of standing orders which would be utilized to make up local departmental burden rates, we might have:

EMLF1—Salaries of foremen and gang bosses in foundry.
EMLF2—Labor in connection with charging cupola.
EMLF3—Labor in connection with pouring.
EMLM1—Salaries of foremen and gang bosses in machine shop.
EMLM2—Labor in operating cranes.

Typical Standing Orders in the Selling-Expense Group

In this group we might have standing orders as follows:

ES1—Salaries of sales manager and assistants.
ES2—Salaries of clerks and stenographers in sales department.

ES3—Salaries of salesmen.
ES4—Salaries of advertising manager and assistants.
ES5—Salaries of traveling salesmen.
ES6—Traveling expenses of salesmen.

Co-operation with Accounting Department

It is absolutely essential that the head of the cost department and the head of the accounting department have a perfect understanding in regard to the collection and allotment of expense data. As a matter of permanent record, it is frequently desirable to designate after each standing order the debits or credits to certain book accounts in the general records. For instance, we might have a standing order worded as follows:

EMLM17—Machinist's time spent in oiling and cleaning up machine (credit pay-roll; debit manufacturing expense).

The information in parentheses is a record of the agreement between the cost department and the accounting department as to the disposal of the item in question. Similar annotations in parentheses may be put at the end of the description of each standing order.

TEST QUESTIONS

1. What are the three principal divisions of expense?
2. In what manner are administrative expenses assessed?
3. In what sort of industries is it fair to allot manufacturing expense by bulk? In what sort by weight?
4. Under what conditions would it be equitable to allot manufacturing expense as a percentage on cost of material?
5. Describe the percentage on direct labor method of diffusing manufacturing expense.

6. Compare the percentage-on-direct-labor method in the case of a man working 20 hours at 30 cents with the case of a man working 30 hours at 20 cents.

7. Describe the hourly expense rate.

8. Illustrate by an example how the hourly expense rate would operate as compared with the percentage-on-direct-labor method.

9. What is the argument in favor of having a variety of local burden rates and an additional burden rate?

10. Would it be practicable to take care of all manufacturing expenses by means of machine rates without having any other expense rates? Explain.

11. Describe the method which allots a budget to each machine.

12. How do we establish a machine rate which shall be distinct from local and general departmental rates?

13. How may we determine whether the machine rates assessed in a given period have fallen under or overrun the correct amount?

14. Give a typical list of standing orders to cover administrative expense.

15. Give a typical list of standing orders to cover manufacturing expense.

16. Give a typical list of standing orders to cover selling expenses.

17. In what way can a cost department co-operate with the accounting department in the matter of standing expense orders?

18. What is the argument in favor of competing companies in the same class of industry adopting a uniform cost accounting system?

19. If the uniform cost accounting system adopted involved a single hourly expense burden, would any advantage accrue to a manufacturer of the association operating under the uniform system, from adopting in his own shop a system which used machine rates, together with local and general burden rates?

20. Could a cost system be applied to the operation of public schools? If so, what would be the unit and what methods of comparison might be adopted?

CHAPTER XI

STANDARDIZATION

Importance of Standards

When we consider how many standards of national and international significance have been the subject of controversy and even wars, and to what extent civilization has been advanced by the adoption of standards and retarded by conflicts regarding standards or by the adherence to false standards, we begin to realize how important the subject is. Such matters as the calendar, methods of measuring the time of day, language—spoken and written, weights and measures, mathematical and scientific units have all been submitted to adjudication by competent authorities, usually after lengthy controversies.

Considering matters of immediate industrial importance, we have commercial standards in accounting methods, engineering standards relating to such things as screw threads, pipe flanges, methods of conducting engine and boiler tests, and many similar examples.

Advantages of Standardization

The advantages of standardization may be discussed from the standpoint of (1) advantages to the proprietor of a business; (2) advantages to the employe; (3) advantages to the consumer.

From the standpoint of advantages to the employer or proprietorship, we may cite the following: (a) Less designing is required and the expense of paying designers is reduced; (b) less labor is required, since everything is uniform and adeptness and speed are acquired by the workers; (c) a less extensive line of materials, equipment, and tools is necessary.

From the standpoint of advantage to the worker, we have (a) greater comfort due to full equipment of all tools and devices to make work easier; (b) greater steadiness of employment, since the making of a smaller number of varieties and styles will always tend to greater stability of business.

From the standpoint of advantage to the consumer we have (a) lower prices; (b) prompt deliveries; (c) a minimum of delays in waiting for repair parts.

Disadvantages of Standardization

The disadvantages of standardization may be discussed from the same standpoint, namely, those accruing to (1) the proprietor; (2) the employe; (3) the consumer.

From the standpoint of disadvantages to the proprietor we may list the following:

1. When competition forces new designs on the market, the specialized machines and tools adapted to old standard designs must be scrapped, causing a large loss. This argument is, of course, a negative one and assumes that standards do change.

2. When processes, tools, and manual operations become standardized, competition becomes greater.

From the standpoint of disadvantages to the worker we have, first, the substitution of handicraft specialists for all-round mechanics. When such a specialist loses his

job he has a hard time finding another. Secondly, since all-round mechanical ability is not demanded, the handicraft man is developed from the ranks of laborers, and wages are low.

From the standpoint of disadvantages to the consumer we have, first, pronounced delay in adopting improved types, particularly in those industries where centralized control prevails. Hand in hand with this objection is the charge of suppressing patents for improved types by the centralized proprietorship which can purchase the patent at its own price, since it constitutes the only sales market open to the inventor. Then we have the difficulty of changing standards which have become widely used, as, for example, the difficulty in adopting the metric system of weights and measures. The above statements regarding disadvantages as well as advantages of standardization are made at the outset, in order that the proper attitude toward the subject may be had at the very beginning of this discussion.

The Field of Standardization

The applicability of standardization in industrial activities may be considered with respect to the same three groups as were considered in connection with the question of general expenses, namely, (1) standardization in the administrative division, (2) standardization in the production division, (3) standardization in the selling division.

Standardization in the Administrative Division

In this division the different steps towards standardization consist of the following:

1. The preparation of the general organization chart showing each department's scope and limits of authority.

2. The preparation of a departmental organization set of charts showing the authority and responsibilities of each individual in the administrative division.

3. The preparation of detailed instructions as to the daily, weekly, and monthly routine of each position.

4. The collection of all the above material into a so-called "book of standards," a copy of which is supplied to each department and which is accessible to any member of that department.

5. The preparation of a book of printed forms. In this book of forms all of the forms relating to a given division of work are designated by a mnemonic symbol followed by a number. This allows indefinite expansion of forms in a given division. When they are pasted on large stiff sheets in a loose-leaf binder it gives the assurance that all of the forms relating to any one division will always be found together. Opposite each form, or underneath it, is pasted a sheet of paper on which are typewritten instructions as to the use of the form. The book of standards will probably make frequent reference to certain form numbers, so that this book of printed forms will have to be frequently consulted. It may be desirable to have several copies of this book made and kept up to date.

6. A list of all the impersonal accounts kept in the books of the company. Such a list of accounts is to be followed by an explanation in ledger form, showing what are the ordinary debits and credits to these accounts and how they are to be closed at the end of each fiscal period and how re-opened at the beginning of each new one. This description of accounts must clearly explain which are controlling accounts and which are subsidiary ones, showing plainly just what type of transactions

each subsidiary account covers, and just what subsidiary accounts each controlling account covers.

7. A detailed list of all reports to the executive as well as of reports to the board of directors and stockholders, together with specifications as to the form of such reports.

Standardization in the Production Division

Standards in this division will refer to the following: (a) organization of production division; (b) product; (c) drawings; (d) patterns; (e) materials; (f) methods of planning and supervising; (g) methods of processing; (h) tools; (i) time standards for machine operations; (j) time standards for handling operations; (k) employes' efficiency standards; (l) wage standards; (m) test standards of product.

Organization of the Production Division

After a definite conclusion has been reached as to the type of control to be employed in the production division, the general organization chart of this division must be prepared, also the departmental charts in the same manner as was outlined in connection with the administrative division. In case the organization involves the inclusion of functional control in an establishment where military line control formerly prevailed, it will be necessary to define clearly in the charts the works manager's limits of authority, as also those of the superintendent and the planning-department heads.

Standardization of Product

This involves a decision on the number of styles and sizes of product which are to prevail. Many industries adopt standards of product for a year. This custom

still prevails in the automobile industry, although even in that the tendency to stick to well-tried standards is becoming more marked each year. In general the changes during the year are only such as are urgent by reason of defects or new inventions. However, the last-named type of changes has to be carefully considered. An over-enthusiastic designing department with plenty of creative talent will naturally wish to place on the market a continuous stream of new designs. Where the industry is a large one, full scope is given to this type of talent by assigning a building (including a good shop) to the construction and trying out of new models. In a smaller industry this is impossible, but developmental work, important as it is, must not interfere with regular production.

Standards in the Drawing Department

The standards in this department will include the division of the drafting work into (a) designing, of which there may be several varieties, such as drafting, tracing, blue-printing, and filing; (b) the adoption of standard sizes of drawings; (c) standards as to quality of tracing-paper, tracing-cloth, blue-print paper, and supplies; (d) standards as to title plates, border lines, lettering (see Fig. 52); (e) mnemonic symbols for parts (Fig. 53) as to drilled, reamed, and tapper holes, bolts, screws, and fastenings in general, and the interchangeable use of minor details, such as gears, bushings, bearings, etc.; (f) the adoption of definite limits of accuracy required in various kinds of fits and methods of designing these limits on the drawings; (g) forms of drawing lists and material lists; (h) filing of tracings, blue-prints, and general information in the drafting department.

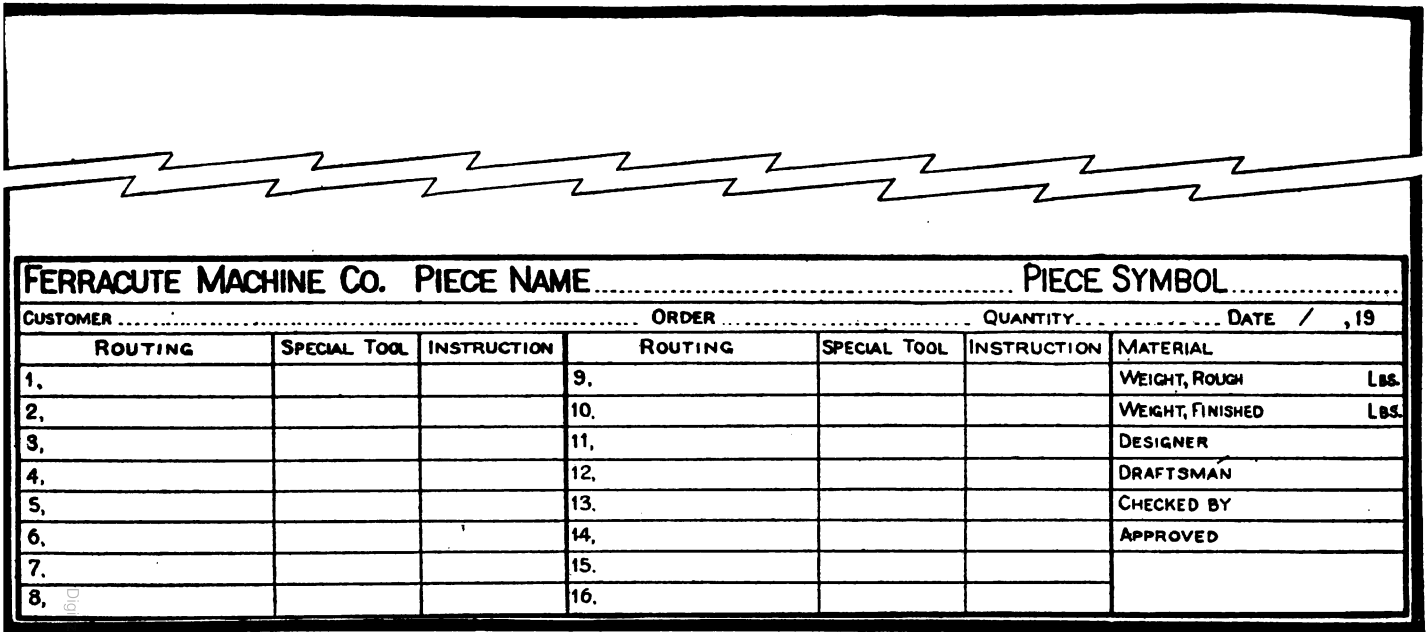


FIG. 52.—Standard Title-Plate, Border-Line, Routing, Tool, Instruction, and Material Reference as Used on Tracing-Sheets at Ferracute Machine Company (Prepared by Frederick W. Parkhurst)

This last-named item is of great importance and requires an intelligent man to take charge of it.

In some organizations an information bureau is established under the general supervision of the head of the

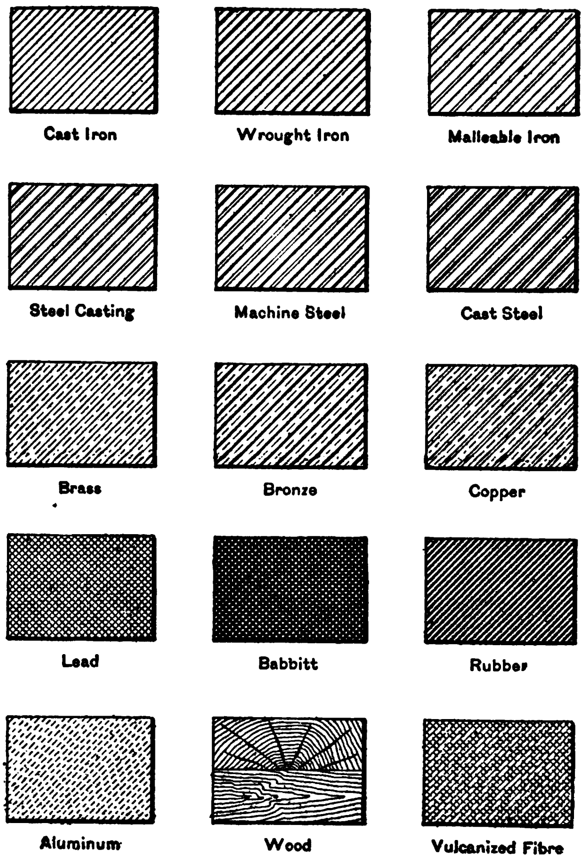


FIG. 53.—Standard Cross-Hatchings to Represent Materials on Drawings (Proposed by Oscar E. Perrigo in *Iron Trade Review*)

planning bureau, such information bureau being located in a place accessible to the drafting department, purchasing department, and planning room.

The Efficiency Society of America has prepared a bulletin outlining a scheme of symbols to be used for filing material for information files, which may be made the nucleus of a system adapted to any particular industry. For example, in their scheme PRt refers to production routine, task; PRtl is the file containing papers, clippings, etc., relating to motion studies; PTo refers to production technique, co-operation; PTol is the file containing papers, clippings, etc., relating to suggestion systems.

The entire bulletin covers twelve pages, in which an attempt is made to classify all topics relating to industrial management, with a symbol for each topic.[1]

Standards in the Pattern Department

In such industries as require castings, whether of brass, copper, aluminum, iron, or steel, the pattern department is one in which the principle of standardization is highly important. The following are the important points to be covered: (a) definite authorization as to making, altering, or repairing patterns; (b) standard procedure as to approval of requests for new, altered, or repaired patterns before the authorization is issued; (c) the determination of how many castings are to be poured from an existing pattern before requested alterations or substitutions of new patterns take effect; (d) definite standards as to shrinkage allowances; (e) methods of accounting for material and labor on each pattern job; (f) the determination of which patterns constitute part of the cost of an order, which are to be considered standard patterns, and what shall be the

[1] The pamphlet may be purchased for $1.00 from the Efficiency Society of America, 41 Park Row. New York City.

method of valuing standard and special patterns for inventory purposes; (g) system of keeping track of location of all patterns, whether in storage in pattern-room, and if so, on what shelf or rack and in what aisle located, and if at foundry, when and how they left and when they should be returned.

Standards in Materials

Definite specifications must be prepared covering the nature of all materials of production, also the routine of buying, receiving, and storing, as explained in previous chapters relating to these subjects.

Methods of Planning and Supervising

While the general organization chart of the production division will outline broadly the functions of the planning and supervising heads, a distinct book of standards for the planning bureau must be prepared, explaining fully the routine of each position accompanied by references to the book of printed forms in use in the various branches of the planning bureau.

Standards in Processing

The data regarding standards of processing are best filed where they may be accessible to the man in charge of routing, the inspector, the man in charge of speeds and feeds of machines, the men in charge of time studies and instruction cards, and their assistants. These data include complete information in regard to (a) the general process-mapping of the business; (b) location of all machines and non-machine processes; (c) existing conditions of all machines as to shaft, pulley, and spindle speeds, methods of changing these speeds, together with

the conditions which are to be the ultimate standards; (d) standard speeds and feeds for stock of various sizes and degrees of hardness for machines in present condition, and standard speeds under conditions ultimately to be reached when all non-standard conditions on machines have been rectified; (e) standard routing for all regular product; (f) standard instruction cards for all regular product.

Standards Relating to Tools

In a metal-working industry these standards will include (a) standard shapes for forging tools, with standard templets and forge-shop devices for adhering to these standards; (b) standard specifications for heating and cooling tools together with the necessary instruments for this purpose; (c) standardized tool-grinding with definite exact shapes and symbols for each shape; (d) tool lists prescribed for every piece of work done; (e) tool storage and issuing system. (See Figs. 54 and 55.)

Time Standards for Machine Operations

Having determined for each machine the speeds at which it shall be run and the rapidity at which either the work or the tool shall be fed, the next set of standards is that relating to the time of the machine, as a machine only, in performing the various operations. These machine-time standards are wholly exclusive of handling time. They do not form the basis for compensation, but are absolutely essential when used in connection with the standards for handling operations and the allowances for length and frequency of rest periods and unavoidable time losses in making up the ultimate time standards for efficiency records of employes.

DIRECTIONS FOR FORGING TAYLOR STANDARD SHAPE CUTTING TOOLS

The blacksmith's work on tools may be divided into four operations common to all:

1—Cutting the bar.	3—Symbolizing.
2—Forging the nose.	4—Hardening.

The first main operation, that of cutting the bar, is, with the exeption of the angle at which the nose-end is cut, the same for all ypes of tools.

The operation is completed as follows :

FIRST—CUTTING THE BAR

Mark bar to be cut in equal lengths, as near standard as possible, using all the steel in it.

At every second mark the cut is made at 90° and the cuts between (for the nose-ends) are made—

For round-nose tools.....at 60°.	For parting tools.........at 90°.
For side finishing tools ..at 90°.	For thread tools..........at 45°

For square-nose tools.....at 60°.

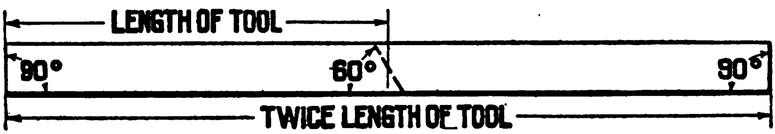


FIG. 9.

The bar thus being properly marked, first with chalk, then with chisel cuts, proceed to cut it into lengths as follows:

a—Put in fire and cut off twice the length of the tool with a chisel.
b—Put the bar and the piece cut back into the fire.
c—Cut off the second double length.
d—Cut the first double length in two.
e—Cut off the third double length from the bar.
f—Divide the second in two.
Etc., etc.

Lengths for standard cutting tools are:

For ½-in. tools—11 inches.	For 1¼-in. tools—21½ inches.
For ⅝-in. tools—12¾ inches.	For 1½-in. tools—25 inches.
For ¾-in. tools—14½ inches.	For 1¾-in. tools—28½ inches.
For ⅞-in. tools—16¼ inches.	For 2 -in. tools—32. inches.
For 1 -in. tools—18 inches.	

Cut off all the tools of one size on the order before beginning the next main operation.

FIG. 54.—Standards as to Forging-Tools to be Used with Taylor Tool-Grinder Manufactured by Tabor Manufacturing Company

CLASSIFICATION OF TOOLS

GENERAL CLASSES

Class

A —Miscellaneous tools not elsewhere classified.

B —Bending tools.—All tools for producing changes in shape by bending, folding, spinning, etc.

C —Clamps and holding devices of all kinds, including bolts and screws.

D —Drilling and boring tools.—Tools that remove metal from the interior, such as drills, boring bars, cutters and all appliances relating to them, and lathe-boring tools, etc.

E —Edge tools.—Edge tools for working wood, and tools for working plastic materials, such as clay, molding sand, putty, etc.

F —Heating tools.—All kinds of tools used for heating, lighting, melting, and molding, oil-tempering, annealing, drying, cooking, etc.

H —Hammers and all tools that work by striking or being struck, such as sledges, tups, etc., chisels, sets, flatters, etc.

L —Transportation tools.—All tools used in moving materials from one place to another, such as buckets, boxes, etc., trucks, shovels, wheelbarrows, bogies, brooms, riggers' tools, slings, chains, etc.

M —Measuring tools.—All instruments of precision, weights, measures, gauges, etc., electrical instruments, etc.

P —Paring tools.—All tools that remove metal from the surface by cutting, except slotter and milling tools. (See class D for lathe-boring tools.)

R —Milling tools.—All tools for milling or sawing metal.

S —Slicing tools.—All parting tools and slotter tools.

T —Templets and all instruments for duplicating work, including jigs and fixtures.

U —Abrading tools.—All tools used for rubbing, scraping, filing, grinding, shearing, punching, breaking, etc.

W —Wrenches and all tools used for causing rotation.

X —Painting tools.—All tools used for covering a surface with an adhesive foreign material, and any for removing the same.

Fig. 55.—Standard Symbols for Classification of Tools, as used by Tabor Manufacturing Company in connection with Taylor Tool-Grinder

Time Standards for Handling Operations

These time standards are the results of time and motion studies made on the motion elements common to various machine and non-machine operations on the product. In the case of such work as excavating, wheeling dirt, shoveling dirt or ore, mixing concrete, and certain other operations, these standards have been reduced to mathematical formulæ. These time standards, like the time standards for machine operations, do not by themselves form the basis for a man's output, but combined with observational data as to length and frequency of rest periods and unavoidable idle time they give the necessary basis for the efficiency records of employes.

Efficiency Standards

The only system of rating the efficiency of employes which has a mathematical basis is one comparing the output during a given continuous period with a standard output. Possibly this efficiency may be multiplied by a numerical attendance percentage. The 100 per cent basis of time on an individual job is usually a combination of time standards on machine and handling time plus allowances for rest and idle time and an addition serving as an incentive. However, the efficiency of an employe rests not so much on making 100 per cent here and there, now and then, once in a while, as on his ability to make a high percentage right along—in other words, on his percentage of success in a given pay period. For instance, a man's percentage of reaching the specified time standards on all jobs in a given pay period figures out 80. His attendance is 90 per cent. His combined efficiency on output and attendance is 72.

There have been attempts to incorporate such factors as skill, cleanliness, and loyalty in the efficiency records of employes, but unfortunately there are no measuring instruments with which to determine an exact numerical basis as to loyalty and cleanliness. Accuracy is taken care of by a good inspection department, and no reward for quantity of production is given where quality is not up to standard. Hence the tendency is to measure the efficiency of employes by output and attendance. Any numerical percentage basis of rating such matters as loyalty, interest, and enthusiasm must depend in the last analysis on the judgment of some superior officer or clerk. This leaves chances for unfairness. Hence it is best not to combine efficiency percentages depending on exact measurable standards with percentages depending on personal estimate and judgment.

Wage Standards

No matter what method of reckoning wages is used as an incentive, reward, or bonus, a fixed scale of wage standards, aside from the incentive, reward, or bonus scheme, should be established. This scale of standards will include the following:

1. A definite rate for persons on trial in an educational try-out division, such as is conducted by publishing and mail-order houses for testing applicants for clerical work. The paying of a fixed rate during this period, such rate being sufficient to cover room-rent, board, and car-fare, will draw applicants from a wider territory and attract a better class of applicants than if no wages at all are paid during the try-out period.

2. A definite scale for each class of apprentices, including promotion every six months. There are usually three classes of apprentices: (a) those without high-school

training or who have had only a year or two in high-school; (b) those who have completed high-school; (c) those who have had a college course.

3. A definite scale of pay for each handicraft or trade, with a definite incentive in the way of promotion in rate at the end of every five years' connection with the establishment. For instance, if the rate for a lathe-hand is 30 cents an hour on entering service, he would receive at the end of five years 32 cents an hour as his going rate, entirely aside from any incentives, rewards, bonuses, or premiums which he might secure. At the end of ten years he would receive 34 cents an hour. At the end of twenty-five years' service he would receive 40 cents an hour. There are not many men who stay twenty-five years in one place, and if they do, they are fully worth the increase in rate indicated.

4. Definite rates as to overtime work. Overtime work should be always the exception, but when breakdowns occur in machinery or power plant, such work is sometimes unavoidable and should be paid for according to a definitely fixed scale.

Standards of Testing Product

In order that the product may be uniform, there must be definitely specified inspections and tests of detail parts, assembled groups, and completed product. These specifications must be put into written form, and such printed forms as require to be filled out must be provided, also instructions to inspectors and members of the testing department, instructing them just how each test is to be conducted. The standard test codes of the national engineering societies on such matters as engine and boiler

tests and similar subjects afford good patterns for such instructions.[2]

Standardization in the Selling Division

This involves standardization as to the organization of this division along the same lines as was indicated in discussing the organization of the administrative and production divisions. It will include further the following standards: (a) standard methods with regard to agents and agencies; (b) standard methods of establishing the selling price; (c) standard methods of packing, shipping, and delivering; (d) standard methods of promising dates of delivery; (e) standard methods of allowing discounts; (f) standard routing of salesmen; (g) standard method of going after and following up "prospects" by correspondence in the central office and accompanying the same by instructions to salesmen; (h) standard methods of advertising; (i) standards as to selecting, compensating, training, and promoting salesmen.

Permanence of Standards

The object of establishing standards is to insure uniformity of procedure along the lines laid out by the most competent authorities. The intent is to leave nothing to the well-meaning caprice or ignorance of individuals. At the same time even scientific standards are subject to revision by competent authorities. However, such revisions do not occur frequently. The same general prin-

[2] These codes may be obtained from the secretaries of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Mining Engineers, and the American Society of Civil Engineers, New York City, being published in pamphlet form. The secretaries of these associations will forward, on application, a list of pamphlets relating to standard tests and other standards, together with price of these pamphlets.

ciples apply to standards in a given industry. A definite committee on standards, with sub-committees on standards in various subdivisions of the industry, may advantageously meet quarterly or semi-annually to consider such matters as may be laid before it.

Essentials of Good Standards

Dr. Rapeer, in a paper before the Pennsylvania Educational Association in December, 1914, gave the following requirements for good standards:

1. They should take the indefinite and vague and make it clear.
2. They must be based on definite scientific laws, or generally agreed upon units and elements.
3. They should "hitch our wagons to a star," but the hitch must be long enough for our wheels to remain on the ground.
4. They should aim to bring our entire population to higher levels of civilization. Clocks, sewing-machines, and bath-tubs are rapidly becoming standard elements of American homes, where but a few decades ago they were absent.
5. They must aim at the solution of dominant life problems.
6. They must be useful in times of change when new occasions teach new duties.

TEST QUESTIONS

1. Give some examples of universal standards.
2. In what way is standardization of advantage to business proprietors?
3. How does standardization help employes?

4. What advantages accrue to the consumer as a result of standardization?

5. How may the proprietorship be injured by standardization?

6. In what way may employes' interests suffer as a result of standardization?

7. How may standardization be disadvantageous to the consumer?

8. What are some of the standards that may be adopted in the administrative division of a business?

9. Discuss standardization of product.

10. What standards should exist in the drawing department?

11. What standards should be established in the pattern department?

12. What standards should be established in connection with planning and supervising?

13. What standards should be established in regard to tools?

14. Discuss the establishment of time standards in machine operations and in manual-labor operations.

15. What standards should be established with regard to processes?

16. Discuss efficiency standards for employes.

17. Discuss standards in testing product.

18. Discuss standards in relation to wages.

19. In what fields can standardization be established in the selling division?

20. List some of the essentials of good standards.

CHAPTER XII

SCIENTIFIC MANAGEMENT

Broad and Narrow Interpretation

The use of the expression "scientific management" assumes that there is such a thing as a science of management. Since the briefest and most commonly accepted definition of science is knowledge carefully digested and arranged, we may define the science of management in accordance with the ordinary conception of science.

In order to do so, however, we must not attempt to confuse with our definition any of the past, present, or future aims or methods of scientific management. If we were to define the science of explosives, we should not attempt to discuss in our definition whether the explosives were to be used for digging post-holes, removing stumps, or waging warfare. If we were to define the science of organic chemistry, we should not enter into a discussion of the merits or demerits of food adulteration.

A definition of the science of management in accordance with our requirements, then, would be the obtaining, digesting, and arranging of all obtainable knowledge relating to the conditions, methods, processes, relations, and results in the field of management, whether that field be manufacturing, distributing, municipal, state, or national government, the army or navy, or educational institutions or systems. Having gathered our data and

established fundamental principles and laws, scientific management would be management in accordance with these principles and laws.

The narrow interpretation of the term "scientific management" conceives it to be the collection of the visible, tangible paraphernalia used by one or another expert or group of experts in applying so-called "efficiency methods" to some particular industry or activity.

Can a Science Have Definite Aims?

The science of management like the science of accounts or the science of chemistry is a valuable tool and can be made to serve the good of the many or the good of the few. A science cannot be called to account for the improper motives of those who may use it as a tool. No one would think for a moment of attacking great chemists or the science of chemistry because it has been made to serve the base purposes of food adulteration. No doubt, valuable data for the science of management could be gathered from the history of bands of train-robbers, political machines, and "get-rich-quick" concerns. A keen and unprincipled proprietor could also utilize the data of the science of management to the disadvantage of his employes and the public.

These negative aspects of the uses to which the data of all sciences have been put are here mentioned since they are frequently brought forward in connection with scientific management. The objectors fail to realize that the information and data disclosed by practically every science are subject to equally grave negative uses. Shall we condemn psychology because the clairvoyant makes use of it? Such a policy would be contrary to scientific research of any kind.

A science as such can have no motives. Those who apply it, however, do have motives, and they will apply

it to carry out their motives. Of scientific management as thus far applied in American manufacturing establishments it can safely be said that the motives of the proprietors of the industrial establishments in which it has been fully developed have been eminently fair toward employe and consumer. The Link-Belt Mfg. Company, of Philadelphia, the Tabor Mfg. Company, of Philadelphia, and the Franklin Motor Car Company, of Syracuse, N. Y., are examples of shops in which scientific management has been applied in a manner which reflects most favorably on those responsible for the application. Dr. Taylor clearly states again and again his aim as the attainment of lower cost of production coupled with higher wages. In general the aims of the leaders in the field of scientific management are the attainment of the most efficient conditions, methods, processes, relations, and results in management.

The term "efficiency" as here used has also a broad and a narrow interpretation. The broad interpretation of efficiency conceives it as the conservation principle in its most general application. It conceives it as the minimum of waste not only in the material and capital of the proprietor, but as the minimum of waste also of human health, energy, and happiness, and as the minimum of waste of the nation's natural materials, as well as the development of the greatest distributed general purchasing power among the community at large. A narrow interpretation would consider a narrow part of this broad application, irrespective of its relation to the other elements.

The Application of Scientific Management

In order to apply scientific management we must first familiarize ourselves with the known published data of

the science of management, and next conduct such researches as give us the particular data needed in regard to our own enterprise. In certain industries these data are most expeditiously secured through the medium of time and motion studies. In other phases of management even of these same industries, and in other fields to which we may wish to apply scientific management, the securing of data means a great deal more than the taking of time and motion studies. We may have to consult the data of related sciences, such as economics, psychology, chemistry, and other natural and applied sciences, including engineering, education, and sociology.

Having secured by careful investigation of known data, supplemented by our own research, all the data practically available and ascertainable, our next task is the establishment of standards. The requirements of good standards have been set forth in the preceding chapter. Just as we speak of one man's standards of morals or ethics being different from another man's, so the management standards of one business will differ from those of another, reflecting to a considerable extent the ideals of the management.

The leaders in scientific management contend that standards must not aim to benefit any one particular individual or group of individuals to such an extent that unfairness is shown to any other individual or group. While it is true that business is engaged in primarily for the profit of the proprietorship, public sentiment is too altruistic to permit the success in the long run of a business whose standards aim at the profit of the proprietorship only, and neglect the rights of employe and consumer.

In general we may summarize that the application of scientific management to a given activity involves:

1. The securing of data.
2. The establishment of standards.
3. Securing means for applying the data and standards.
4. Securing means for seeing that the data and standards are utilized.
5. Providing means for further investigation to secure new knowledge.
6. Securing the maximum of prosperity for employer, employe, and consumer.

The Securing of Data

There are several most interesting publications showing the unprejudiced and painstaking research work required to secure the data necessary for scientific management. Among these are Taylor's *Art of Cutting Metals,* Gilbreth's *Brick-laying System* and *Concrete System,* and Taylor and Thomson's *Concrete.* In his experiments on metal-cutting Taylor conducted over 50,000 experiments involving the removal by cutting tools of over 800,000 pounds of steel, at a cost of nearly $200,000.

The data investigated relate not only to the materials, machines, and methods, but also to the scientific selection and study of the workers as a result of the physical and psychologic qualifications of the men best able to perform the various duties.

After the data have been secured they are reduced to standards. The previous chapter of this text has already discussed quite fully the question of standards and standardization. Another chapter will be devoted to the important question of time and motion studies. These aim

to reduce industrial processes to units. These units will relate to machine operations and to non-machine operations.

Applying the Data and Standards

The application of the data and standards discovered in a study of scientific management involves the question of organization and control as well as equipment. For example, it is quite likely that we may wish to regroup existing departments and place in charge of a functionalized controlling system those men in our existing organization best adapted to carrying out the function at the head of which it is proposed to place them.

Next it is essential to see that the data and standards are utilized. This requirement demands that there must be provided a sufficient force of teachers and demonstrators to work with those who are to utilize the data and standards to get them into successful use. The teachers and demonstrators must be capable, enthusiastic, and sympathetic optimists with pleasing address. There must be a decided incentive for success offered the workers.

Making Further Investigations

Certain investigators must be continuously at work along lines which are not routine, in the effort to devise improved methods and effect further economies. These investigators will include not only members of the staff, but also men in the ranks competing for a reward through the medium of a well-organized suggestion system.

There is also a national organization known as the Society for Promotion of the Science of Management and limited in membership to persons who have done actual work in promoting the science of management, which

society endeavors to promote research work by government bureaus, by engineering colleges, and by experts on their own initiative.

Securing the Maximum of Prosperity for All Concerned

This requirement demands that (a) the proprietorship shall receive the largest dividends which can reasonably be expected, giving due consideration to the interests of employes and consumers; (b) the employes must receive not only the highest prevailing wage accorded to their various crafts, but incentives, financial and otherwise, to encourage high standards; (c) to the consumer must be given his share of the benefit of improved methods by reducing the price to him of articles for which in the past he has been paying a higher price, or he is to receive a better article at no increased price.

Taylor's Principles of Scientific Management

The chief aim of scientific management as formulated by Mr. Taylor is the lowering of costs of production coupled with higher pay for labor. He stated that this aim is to be attained through:

1. The working up for every activity or industry a science to replace the traditional or rule-of-thumb knowledge possessed by all connected with the activity.
2. The scientific study of the workers—finding out the human characteristics required for every class of work in the given activity.
3. Bringing the science to the workers through the medium of the planning department and the functional instructors in the shop.
4. The assumption by the management of its due share in the foregoing three divisions.

Conclusions of the American Society of Mechanical Engineers

A committee of the American Society of Mechanical Engineers made an extensive canvass and investigation in order to determine the leading principles of management, and reported the following:

1. The planning of the processes and operations in detail by a special division organized for this purpose.
2. Functional organization, by which so far as possible each man superintending the workmen is responsible for a single line of effort instead of intrusted with a combination of executive, legislative, and judicial functions.
3. The training of the worker in the best methods.
4. Equitable payment of the workers based on quantity and quality of individual output.

Obstacles in the Way of Scientific Management

Taylor in his book *Shop Management* stated that the principal obstacles in the way of scientific management are:

1. "Soldiering" by the workers, this being due to (a) ignorance, (b) intentional through fear of reduction of piece rates or of over-production and the employes' "working themselves out of a job."
2. The ignorance of the management.

The publishers of the American Magazine printed serially in their issues of March, April, and May, 1911, a group of papers on "The Principles of Scientific Management," by Frederick W. Taylor. As a result, hundreds of letters came to the publishers of the magazine from all over the world mentioning objections and obstacles.

Dr. Taylor turned these letters over to Mr. Frank B. Gilbreth, who answered them in a small and very interesting book written for the general public and entitled "A Primer of Scientific Management."

In general the obstacles may be classified as:

1. Objections by the proprietorship.
2. Objections by employes.

Objections by Proprietors

These objections are the following:

1. It involves too high an overhead or manufacturing expense.
2. It disorganizes well-established relations.
3. Employes studying about the methods of scientific management will become discontented with actual conditions.

OVERHEAD OR MANUFACTURING EXPENSE

Experience has shown that a remarkably increased output can be obtained with the same number of employes assisted by a competent expert, after scientific management has been established. To be sure, certain employes classed formerly as "producers" would be put under the traditional designation of "non-producers," since they are now planners and instructors instead of mechanics. So long as production has been increased and costs reduced, what difference does it make whether an arbitrary classification of planning and instructing work into non-productive or overhead cost makes that class of expense higher than under traditional methods?

DISORGANIZING OF ESTABLISHED RELATIONS

Scientific management cannot be installed in a month or even in a year. It can seldom be introduced in less

than three years, and it may take twice that time. When time enough is taken, the process is an evolution and not a revolution. Experience has demonstrated that even during the transitional period the balance sheet shows favorable results financially.

DISCONTENTMENT WITH TRADITIONAL CONDITIONS

Instead of being a danger, this element is a favorable sign, since employes as well as the management will be interested in securing the ultimate results.

Objections by Employes

These are chiefly:

1. It is humiliating to have a man stand over you with a stop-watch.
2. Working under standardized instruction throttles initiative.
3. The employer having found out the highest possible speed will cut the rate of pay.
4. Too many bosses.
5. Pay based on individual merit is contrary to the principle of collective bargaining.

STOP-WATCH OBSERVATIONS

These are taken only in order to determine elements of machine and handling operations. They are taken on trained workers who are paid an advanced rate of pay while acting as demonstrators. A time study should never be taken on a man without his consent or surreptitiously. Due allowances are always made for rest periods of adequate length and frequency when the time elements are assembled into instruction cards. Experience has shown that in plants where scientific management has

been introduced the men enjoy participating in the research work of time and motion study.

PREVENTION OF INITIATIVE

The opportunity for initiative lies in the rewards offered in a well-managed suggestion system. Suggestions are always welcomed, but the employe must submit to the discipline of teachers and demonstrators whose instructions are based on the co-operative study of the best workers in the plant in establishing existing standards. If a worker sees a new and better way, he reports it in the form of a suggestion, and is adequately rewarded when his suggestion is found workable and adopted.

CUTTING THE RATE OF PAY

Any employer who is sufficiently progressive to introduce scientific management knows that all advocates of scientific management condemn rate-cutting as the worst defect of traditional management. It is a procedure which the management should guarantee will not occur under any circumstances. It does not take much foresight to appreciate the fact that rate-cutting would put an end to all efforts for co-operation, and that there can be no such thing as scientific management or even continued success of the business under any form of management where this vicious practice is indulged in. If your management can't be trusted, it is best to quit anyway. It is fair to assume that it is honest until proved otherwise.

TOO MANY BOSSES

In actual practice the presence of functional bosses is not noticed, but the results of their activities are very

manifest. Instead of asking what to do next or where to find the tools, drawings, or material, the mechanic is relieved of concern as to these matters, the next job, together with the tool list, tools, instruction card, and bonus schedule, being ready for him before he finishes the work on which he is at present engaged. If he has trouble and needs help, a competent helper will come to his aid.

COLLECTIVE BARGAINING

Scientific management has no controversy relative to collective bargaining. It recognizes a minimum day or hourly rate for every craft and is willing to pay the maximum prevalent scale. It does demand, however, that each worker perform his duties in accordance with instructions and it reserves the right to pay additional wages to the most efficient workers over and above the rate arrived at as a result of collective bargaining.

TEST QUESTIONS

1. What is your definition of scientific management?
2. What have the leaders in the field of scientific management stated as their aims?
3. What consecutive steps are involved in the application of scientific management to a given industry?
4. How are data secured for scientific management?
5. After the data are secured what means are to be adopted for applying them?
6. How can the utilization of data and standards be enforced?
7. What methods should be adopted to carry on continuous investigations and researches?
8. How can proprietorship, employes, and consumers get their respective shares of the benefits of scientific management?

9. What are Taylor's definitions of the aims and principles of scientific management?

10. What are the principles of management as reported by the committee on management of the American Society of Mechanical Engineers?

11. What does Taylor state as the principal obstacles in the way of scientific management?

12. Compare the manufacturing expense factor under scientific management with that under traditional management.

13. Discuss the possible disorganization of existing relations after the introduction of scientific management.

14. What is the proper way to take stop-watch observations?

15. Discuss the effect of scientific management on the initiative and inventive spirit of employes.

16. How is the compensation of the worker affected in the long run by scientific management?

17. How does scientific management contrive to make it possible for a worker to be supervised by a number of different bosses?

18. Discuss the relation of collective bargaining to scientific management.

19. In what ways does scientific management bring the employers and the employes into closer relations?

20. How would you apply scientific management so as to avoid the criticism that it makes a mere tool or machine of the worker?

CHAPTER XIII

TIME AND MOTION STUDIES

Definitions

Time study is the analysis of any process into the smallest elements or sub-operations into which it can be divided. These processes may be manual or mental or machine processes. The elements may be preparatory, supplementary, consecutive, or simultaneous. After the analysis indicated has been made, each element is examined and investigated as a separate unit.

Motion study is the investigation of the movements involved in each element, with the object of eliminating all waste. This waste may be waste of time, energy, health, materials, or tools. Motion study involves consideration of such factors as experience, skill, contentment, fatigue, training, habit, and prejudice.

Standard Elemental Operations and Times

Standard elemental operations are such as repeat themselves again and again on all kinds of work. They include the following: "Pick up tools," "Walk to vise," "Lay down tools," "Set work into machine," "Clamp work into machine," "Raise work from floor to machine." It will be seen that work of several varieties can be classified as to weight and shape, and fastening can be classified according to various sizes and styles of clamps and bolts.

Raising from floor to machine may be classified as to various sizes and weights, and as to whether the raising is by hand, by hoist, or by crane, etc.

It is assumed that prior to undertaking time studies all

TOOL LIST FOR — **OPERATION** Exercise #4

MACHINE No. L. 10 **DRAW. Nos.** 504

PIECES	NAME	SIZE	TOOL SYMBOL
1	Hammer	1 1/2	H. M. M.
1	Center Punch		H. C. C.
1	Hermaphrodites	6"	M. C. F. H.
1	Lathe Tool	5/8X1"	P. V. V. A.
1	" "	"	P. R. S. E.
1	Steel Scale	6"	M. S. S.
1	Caliper	6"	M. C. F. S.
1	Center Gauge		M. G. A.

FIG. 56.—Tool List

possible efforts will already have been made to standardize the procedure of getting material, tools, drawings, clamps, and other fastening devices. For example, Figure 56 shows the tool list for the work illustrated in the subsequent figures. The next procedure is the listing

TIME STUDY

EXERCISE #4

(1.)

OBSERVER Trac

OPERATC

SURFACE SPEED	SPINDLE SPEED	FEED	DEPTH OF CUT	DETAIL OPERATION
				1. Pick up tools
				2. Walk to Vise
				3. Lay down Tools.
				4. Chalk both ends
				5. Put down Chalk + Center He
				6 Center Both Ends.
				7 Put down Scriber + pick up
				8 Center Punch both Ends.
				9 Pick up tools.
				10 Walk back to Machine.
				11 Put down tools + pick Center
				12 Walk to Speed Lathe
				13 Lay down piece.
				14 Put drill in chuck.
				15 Start Machine.
				16 Center Both Ends
				17 Stop Machine
				18 Take out drill
				19 Walk back to Machine.
				20 Lay down drill + get do
				21 Put dog on piece.
				22 Put piece between adjust
				23 Pick up Side Tool
				24 Set Tool.
				25 Change Speed + Feed.
				26 Start Machine.

FIG. 57.–

"Conti" stands for continuous time consumed

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of all the detail operations without any attempt at accurate timing. Figure 57 illustrates the time-study observation sheet. The broad column with the heading "Detail Operation" is first filled in by the observer. In some cases it will take two or three sets of observations to list these details when the process of taking time studies is first being initiated.

Method of Timing Observations

Figure 58 shows a board arranged to hold the time-study observation sheet, the sheets being held to the board by a so-called giant or bulldog clip. At the upper left-hand corner of the board is a projection with cup hooks arranged to hold the stop-watch. The operator starts and stops the watch with the left hand while he is taking notes with the right hand, as shown in the figure. The stop-watch has the minute divided into 100 divisions instead of into seconds. This makes it easier to calculate the elapsed time or individual time, as indicated in the alternate columns on Figure 57. The watch is so arranged that, after having been stopped, it can be started again for the second operation at the point at which it was stopped instead of being thrown back to zero. This feature enables us to stop the watch whenever any unusual interruption takes place. It also gives us the total elapsed time from the start of the first reading.

Moving Pictures as an Aid to Time Study

Mr. Frank B. Gilbreth has used with marked success the motion camera as an adjunct to scientific management. While actually performing his work the mechanic is photographed by the machine. His every movement is recorded on the films. As he works, a specially designed clock is so placed as to appear in the picture, recording

the exact time taken by every movement. The clock dial is about 30 inches in diameter and has a pointer which makes ten complete revolutions of the dial in a minute. The dial itself is divided into 100 parts, so that each movement of the pointer represents 1/1000 of a minute. A permanent record is thus secured. The expert is enabled to study the operation in detail for the purpose of eliminating all useless motions. The unnecessary motions of the workman having been so clearly revealed, new and shorter ways of doing the job are devised.

At the plant of the New England Butt Company, Providence, R. I., a job which formerly required 37½ minutes is now done in 8½ minutes as a result of the micro-motion study. In many other jobs the time has been cut down until the work is now done in from one half to one fourth of the former time. When a workman reaches out his hand to pick up a tool, the time of the movement is shown by the film. By noting the position of the pointer on the clock in the picture showing the beginning of the movement, and its position in the picture showing the end of the movement, the precise time is ascertained.

It is in the analysis of these motions that the moving-picture machine has been utilized by Mr. Gilbreth. Close study of the films showed that a great many of the motions of the various workmen were wholly unnecessary—also that a great deal of useless work was done in picking up pieces from boxes and trucks on the floor when these pieces, if arranged on an assembling-board, could be reached for and put into position in a much shorter time. As a result, various styles of so-called "assembling-boards" were designed upon which cheaper help in the stock room placed the various lighter parts of machines to be assembled. When the expert mechanic was ready to assemble the machine, the use of the assembling-board

FIG. 58.—Method of Mounting Observation Sheet and Stop-Watch on Board for Taking Time-Study Observations

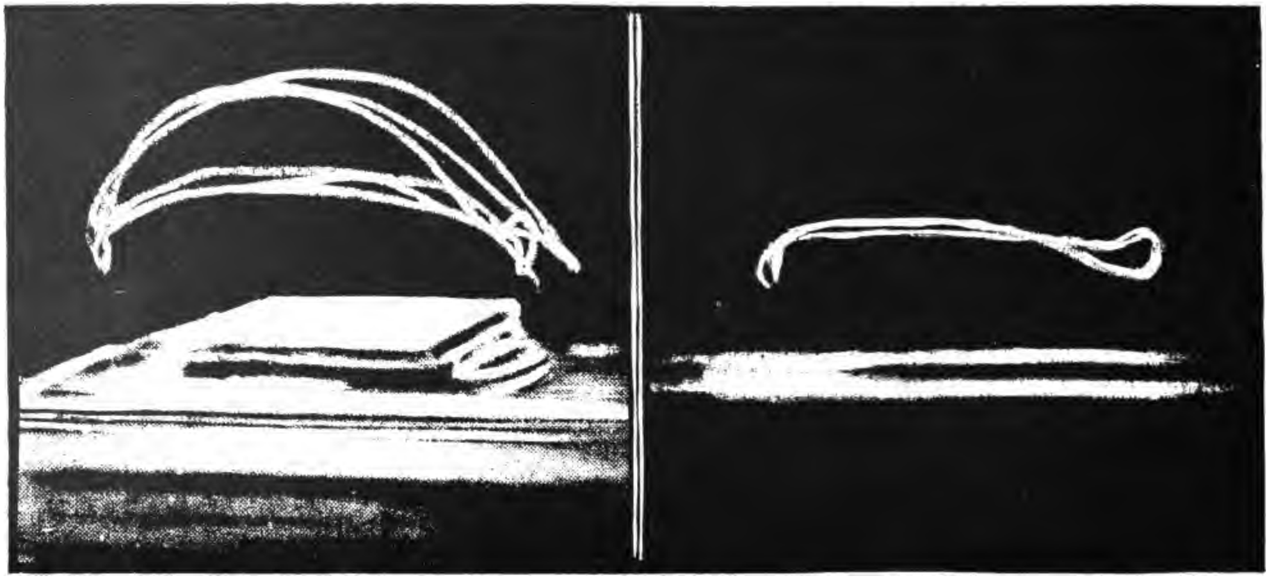

FIG. 59.—"Before and After Taking"

The bands of light are the records made by an electric bulb carried on the hand in moving photographs from one point to another on a table. On the left is shown the natural movement of the hand. On the right is the shorter path taken by the hand after the first photograph had been studied and the hand trained to move in straighter lines.

eliminated a great deal of the time formerly lost in bending down and stooping over.

Mapping Motions

Another device used by Mr. Gilbreth consists in attaching a small electric light bulb to the hand of the operator, the bulb being connected by flexible wiring with a battery or other source of current. The light in the vicinity of the operator is slightly darkened so that the electric light in the hand rather than the man and machine will be recorded on the photographic plate. The camera is trained on the worker as he performs the operation which is under investigation. The plate is exposed as long as is necessary for the completion of several complete paths of motions.

When the plate is developed, it will show a line of light traced in an irregular path. The figures of the man and machine may be faintly visible, but they do not count. The main thing is the path made by the light which shows exactly the path that the operator's hand traversed in the operation (Fig. 59). Where the light has passed two or three times over the same path it will be expanded to a broader band. This band is an accurate record or map of the motion which is being studied.

In the majority of cases it will be found that the path is not in a straight line, but represents a curve more or less complicated. The straight line would be shorter. The problem then resolves itself into providing such fixtures, stands, or tools that the path may be shortened, and also that the workman may be trained in new habits of motion such as will assist in shortening the path.

Where the record of light shows a path full of twists and angles, Mr. Gilbreth reasons that something must be the matter with the arrangement of the parts which the

hand must reach. For example, at the plant of the New England Butt Company one of the plates showed that the operator of a certain machine made a considerable reach of the hand in order to seize a certain lever. The operation had become habitual, and even the trained eye of the efficiency expert failed to note that there was any unnecessary movement. The photographic record, however, showed that this reaching was an extra complication which resulted in some loss of time. The mechanism of the machine was altered so that the lever was within short reach of the workman.

In order to introduce the time element, Mr. Gilbreth devised a disc whose revolutions make or break the electric current leading to the lamp on the operator's hand. Instead of a continuous line or band the photograph of the machine will now show a line of dots and dashes. By gearing the disc which makes and breaks the circuit to a definite speed the number of flashes in a second is known. If there are ten flashes in a second and a line representing movement of the hand shows thirty flashes, the motion has taken three seconds. The shape of the flash, blunt at one end and sharp at the other, shows in which direction the motion was made. Mr. Gilbreth has designated this type of motion record as a cyclegraph, since each plate records the complete cycle of motion.

Figure 60 illustrates the clock used in micro-motion study work. Figure 61 shows a cinematograph motion study being taken at the New England Butt Company. It will be noticed that the floor and background are cross-sectioned so as to make more easy the determination of surrounding conditions and motions. Figure 62 shows a typical set of micro-motion pictures. The cross-sectioned background has the heavy lines 12″ apart and the light lines 4″ apart. An inspection of the pictures

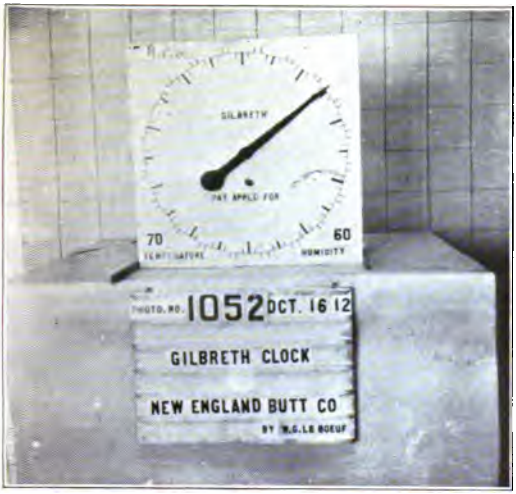

FIG. 60.—The Gilbreth Clock
This clock records 1/1000 of a second. It shows the exact time taken by every motion made by the workman.

FIG. 61.—Time and Motion Observations by means of the Moving-Picture Camera
It is sometimes difficult for the workman to concentrate his attention upon his work when subjected to the moving-picture ordeal. The mechanic shown in this picture is unconsciously "posing."

FIG. 62.—Moving - Picture Film Used in Studying Assembly of Small Ma-chines

Fig. 63.—The Rack from which the Workman Assembles the Different Parts of the Machine He is Making

Fig. 64.—Group of Students Taking Time-Study Observation in the Machine Shop of the Pennsylvania State College

shows that it takes a man one second to let go of the work he was doing and get his hands to the assembling-board. Figure 63 shows an assembling-board with the various parts of the braider machine arranged in sequence of use in assembling the various features for holding the parts which have been designed particularly with reference to use and quickness of grasping.

Qualifications of Time-Study Observer

It is desirable, although not absolutely essential, that the observer be trained in the trade under observation. He need not necessarily be an expert. He should be patient, diplomatic, and unprejudiced. College training in laboratory practice in which a man has become accustomed to taking accurate readings is good preparation for this work, provided it has been followed by some shop training in the trade involved.

The workman on whom the time study is made should always be informed of its purpose, and his interest and co-operation secured. Time study for the purpose of getting the motion and time elements should always be made on first-class men, and such percentage of extra time added in establishing a time limit as will afford an incentive for the average man.

It is customary to pay an advance over a man's ordinary rate when he is acting as a subject for time and motion studies. This extra pay is in no sense in the nature of a bribe, but it is in recognition of the fact that the man is being called upon to assist in a higher grade of work, since he and the time-study man are now doing team work of a research nature, which is a higher grade of work than ordinary production. The workman may be called upon by the time-study man to stop suddenly in the midst of a process, and to think about certain motion

elements involved, and discuss whether these elements are ordinary practice, or whether a certain improvement, short cut, or device suggested by the time-study man is feasible or not, and many similar matters.

Preparation of the Instruction Card

Figure 65 shows a drawing of the part on which the time-study observations shown in Figure 57 were taken.

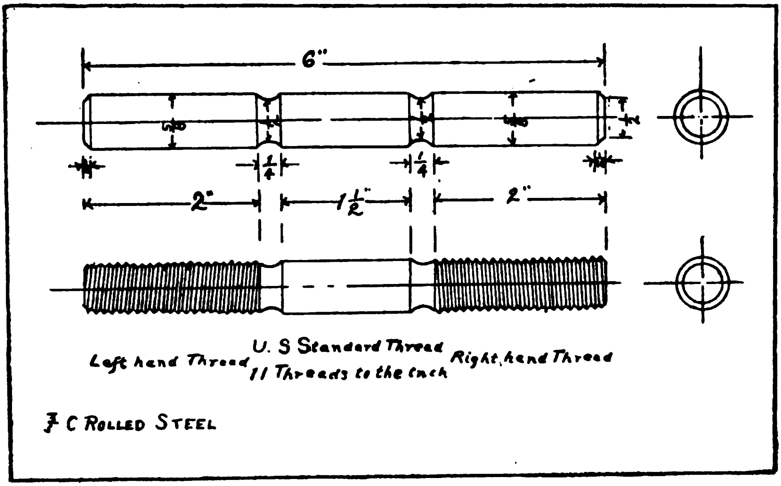

Fig. 65.—Drawing of Piece on which Time-Study Data Were Taken Shown in Fig. 57

Figure 66 shows the instruction card which is the synthetic or constructive result of the analytic or observational operation known as the time study. It will be noticed that in the instruction card each element or sub-operation is distinctly listed and the standard time which has been agreed on is listed after each sub-operation.

After the time-study work has progressed to such an extent that a considerable variety of standard elemental

operations and times have been listed and filed, the building-up of the instruction card for a new piece will consist very largely in assembling these standard elements, leaving only a few elements remaining, for which the time can frequently be figured from known data, so that the actual time-study work becomes less all the time, and the result of every additional time study becomes more and more extensive. Figure 64 shows a group of students at the Pennsylvania State College taking time-study observations in the machine shop.

Doing the Work According to Instructions

Where the men have never worked under instruction cards, it will require patient and systematic training and an insistence on careful reading and following of the individual steps of the elemental operation instructions. At the beginning men who have been accustomed to looking at the time consumed on a job merely in the light of the total time are apt to consider impossible the time reductions indicated on most instruction cards.

The writer had experience of this sort in the assembling of automobiles and of engine-governors. After considerable preliminary work in planning and getting materials and tools ready, accompanied by careful time studies, it was decided to offer a bonus in the case of automobile-assembling, beginning at 100 total hours of assemblers' time. The best previous record had been 225 hours. With careful handling of the men the time was reduced at the first to 90 hours and ultimately it was a common occurrence for the total assembling time to take no longer than 65 or 70 hours. In the case of steam-engine governors a great deal of time had been lost by reason of poor fits and the necessity of having the assemblers do a great deal of filing. After the adoption of

INSTRUCTION CARD FOR OPERATION				
SHEETS, SHEET No.		DRAWING No.	MACHINE No.	ORDER No.
MATERIAL	CLASS No.	PIECES		

DESCRIPTION OF OPERATION Center, Face, Turn, Groove, Thread

ITEM	DETAILED INSTRUCTIONS	FEED	SPEED	Element Time per Piece	Time for Entire Lot	Continuous or Running Time
1	Pick up tools			.07		
2	Walk to vise			.03		
3	Lay down tools			.02		
4	Pick up chalk and chalk both ends			.11		
5	Lay down chalk and pick up center and scriber			.02		
6	Center both ends			.25		
7	Lay down scriber and pick up center punch			.05		
8	Punch both ends			.25		
9	Pick up tools			.06		
10	Walk back to machine			.04		
11	Lay down tools and pick up center drill			.04		
12	Walk to speed lathe			.06		
13	Lay down piece			.03		
14	Put drill in chuck			.44		
15	Start machine			.02		
16	Adjust tail stock			.06		
17	Drill both ends			.60		
18	Stop machine			.02		
19	Take out drill			.28		
20	Walk back to machine			.07		
21	Lay down drill and pick up dog			.05		
22	Put dog in piece			.08		
23	Put piece between centers and adjust			.25		
24	Pick up side tool			.10		
25	Set side tool			.40		
26	Start machine			.05		
27	Change speed and feed			.10		
28	Face first end			1.33		
29	Stop machine			.02		
30	Take out piece			.10		
31	Take off dog			.10		
32	Measure to length			.39		
33	Put dog on piece			.15		
34	Put piece between centers and adjust			.23		
35	Start machine			.02		
36	Finish face to length			1.06		
37	Stop machine			.03		
38	Take out side and put in round			.17		

	Month	Day	Year	Signed
				Checked

FIG. 66.—Instruction Card for the Piece Shown in Fig. 65

standard limits on the parts which were to be fitted together, the total time of assembling governors was reduced to about one-third of the former time.

A skilled demonstrator or leader needs to remain with the workers until they are able to do the tasks specified in the instruction cards, and within the time limits designated. When a job has reached the stage where it is continuously done in the time specified, it can be safely left alone. Frequently, however, after considerable savings have been made on work done by an experienced man or group of men, when a new man or group of men undertakes the same task, it takes a much longer time. Under these circumstances it is quite likely that the services of the demonstrator or leader will be again required.

Allowances for Exceptional Conditions

Where there is a difference in the quality of material, such as, for instance, in cast iron or cast steel, in which there are frequently as many as three classes of hardness recognized, a definite procedure should be agreed on regarding alterations in the surface speed and depth of cut to be used, together with the consequent results to be put in the time standards of the instruction sheet. In case there is a functional foreman in charge of the feeds and speeds, he would be the man to pass judgment on the quality of the metal. In case there is no such official, the foreman would be the man to make the decision.

There should be no allowances made for the cleaning of a machine while the work is in process of being done, or of any oiling not specified on the instruction sheet. In case of delay for making a necessary repair, this should be approved by the functional repair boss, if there is such

a man in the organization, or, in the absence of such a boss, by the foreman.

Time Study Does Not Mean Driving

Scientific time study recognizes the fact that the worker must not use too much strength and vitality at one stretch. This is important. It is not only requisite to know that in some classes of work the necessary rest periods aggregate two hours a day, while in certain other classes of work they are as high as one-half of the total working time. It is necessary also to know how long a man should work between the rest intervals in order to avoid fatigue. For example, in the case of a skilled drop-hammer blacksmith, we might know that, generally speaking, a man would need to rest approximately one-half of the working time. We shall have to know also whether it is best to work five minutes and rest five minutes, or to work ten minutes and rest ten minutes. This information can be gained only by careful experiment.

It must also be borne in mind that interest in one's work will lessen fatigue. Hence a man's mental attitude towards his work means a great deal. The development of loyalty and enthusiasm among the employes, as well as the employment of the right sort of men to take the time studies, will do much towards keeping up the man's interest in the work. A suitable system of extra remuneration for work done in accordance with instructions, and within the time limits specified, will also tend to keep up the interest, especially if each job is made the subject of a distinct bonus chart applicable to the particular machine, or to conditions at the particular production center where the work is being done.

The scientific determination of the amount of fatigue after continuous exertion of various kinds and for certain

lengths of times has been investigated by various experimental psychologists.[1] One method employed is to utilize an instrument recording by electrical contact with the pulse the rapidity and pressure of the pulse, which acts as an indicator of the fatigue.

Where the facilities are not at hand to make scientific tests to determine the frequency and length of pauses and rest periods, the common-sense and good judgment of an experienced observer of the methods pursued by the workers who show a combination of greatest output with least fatigue must decide the questions. The power of resisting fatigue varies with training, occupation, surroundings, and the constitution of the individual. Where the work is repetitious for a long time, a change in position will frequently afford a change in blood-pressure, which will prevent fatigue. To this end special stools have been devised with foot and back rests, so that the position is easily changed. Fatigue is worthy of study in every industry. Workmen must be taught to husband their energies, as fatigue interferes not only with their industrial efficiency, but also with their social efficiency.

Inspection

A thorough system of inspection is a necessary accompaniment of any system employing instruction cards, time standards, and bonuses. The system of inspection, to be

[1] The following authors have contributed to the literature of fatigue:

J. Goldmark, *Fatigue.*
F. S. Lee, *Fatigue.*
A. Mosso, *Fatigue.*
F. M. Stratton, *Experimental Psychology.*
C. S. Yoakum, *An Experimental Study of Fatigue.*
Adelson, *Mental Fatigue.*
Arai, *Mental Fatigue.*

thorough, involves the employment of floor inspectors who accompany the move-material men in transferring work in process from department to department. The move-material men move from one department to the next such work as is approved by the inspectors. In some well-equipped establishments a motor-driven truck provided with storage batteries is used to facilitate the rapid transportation of work in process, move-material men, and inspectors from department to department.

The Expense of Time Studies

It must be borne in mind that, after standard elemental operations have been timed, these operations will be found to repeat themselves again and again, so that the time spent in a complete analysis of a new job is trivial after time study has been well established. At the beginning of time-study work it may take several days to analyze a job, while after six months of time-study work a similar job would take but a few minutes by reason of standardized data available.

Desirability of Publishing Time-Study Data

It is unfortunate that the great accumulation of time-study data which have been gathered in various machine shops cannot be published and made available. It is hoped that educational institutions and government bureaus will undertake the determination of standard time elements in various classes of work and publish them for the benefit of the public.

TEST QUESTIONS

1. What is time study?
2. What is motion study, and how does it differ from time study?

3. What are standard elemental operations?

4. Why is it advisable to make the standardization of elemental operations the first and most important phase of time and motion study work?

5. Describe in detail the method of timing observations with a stop-watch.

6. What are the qualifications of time-study observers?

7. Describe the application of moving pictures to time-study work.

8. Describe the cyclograph method of mapping motions.

9. How is the instruction card built up from time studies?

10. Why is it desirable to inform the workman to be studied that time study is to be made on him?

11. How may we assist and encourage men in doing work in accordance with instruction cards?

12. What allowance should be made for variable conditions?

13. How would you meet the objection that time studies and instruction cards tend to drive men?

14. How would you meet the objection that time studies and instruction cards make machines of men?

15. What attention must be given to instructions when men are working under instruction cards?

16. What is the argument justifying the expense of time studies?

17. In what way does the element of fatigue enter into the establishment of time standards?

18. How do you account for the opposition of organized labor to time studies?

19. Discuss the advisability of publishing time-study data.

20. What methods have you to suggest whereby proprietor, worker, and consumer could secure their fair share, respectively, of the benefits of time and motion studies?

CHAPTER XIV

WAGE SYSTEMS

General Classification of Wage Systems

The methods which have been devised for remunerating labor may be classified into three general groups, as follows:

1. Time work, in which the employe is paid by the hour, the week, the month, or the year.
2. Contract work, including (a) the ordinary piece-rate method, (b) the differential piece-rate method, (c) the collective contract, whereby a contractor agrees to furnish the labor for a certain quantity of product at a certain price, the contractor selecting his own method of remunerating those who work for him.
3. Bonus, efficiency, or premium systems, including (a) promotion systems under day rate as a reward for increased efficiency, (b) the Halsey premium system, (c) the Rowan premium system, (d) the bonus system, (e) the efficiency system, (f) combinations of the above.

Time Work

Under this system in its usual form there is no record of the individual's performance. There is no incentive for effort except of such a sort as will result in the employe's being designated as a "good man" by the foreman or other superior. There is no penalty for ordinary

inefficiency or time-killing. As soon as we introduce any kind of reward for individual efficiency, we are departing from the traditional time work or day rate, even though our reward may be of a sort which is not recognized among the so-called bonus or premium systems of pay.

It is possible to introduce time and motion studies and instruction cards, together with standardized routing, scheduling, moving of material, and functional foremanship in connection with the traditional day rate; but unless some inducement is offered to the employe to reward him for sustained effort to follow out the instruction cards and for his success in so doing, together with some penalty for failure to put forth effort, we shall not realize more than a fractional part of the advantages which can be gained from standardization and planning. Some advantage will surely accrue in the way of economies and avoidance of waste in materials and labor—indeed, the advantage gained will be such as to pay for the work done and also a handsome profit; but unless a reward is offered, there will be too many cases of backsliding and neglect of the instruction cards.

Proper supervision as well as standardization and planning, and good working conditions, such as are developed by proper welfare activities, will go a great way toward remedying time losses under a day-rate system. These conditions are, in fact, necessary prerequisites to the introduction of any other system of remuneration. It is always desirable to leave the wage question as the last problem. This placing it at the end of the list does not mean that it is a problem to be feared or avoided, or that it is of minor importance. It is a problem to be met in a liberal, tolerant manner, but it must be met and solved, since it is of vital importance.

If America is to maintain its industrial standing, it must practice to the fullest extent conservation of labor-energy while at the same time securing the highest efficiency out of its labor-energy. America's aim is to have the highest paid labor in the world. This means that we must face international competition at home as well as abroad. There is hardly any establishment or undertaking in which, no matter how variable the individual items of product made, the elemental sub-operations are not repetitious. Hence, time standards are practically universally ascertainable, and our verdict on time wage with no stimulus for the loyal and efficient and no punishment for the disloyal and inefficient is that it is merely a temporary expedient.

The foregoing remarks apply to the crude traditional class of day work in which the workmen of a given trade or handicraft are paid a class rate, regardless of individual merit. As soon as we have established elemental time standards and instruction cards, we begin to realize that good workers are worth twice or three times as much as poor ones. This immediately suggests some system of compensation or promotion under the day-rate method that will recognize individual merit. Such a scheme will naturally fall under our grouping of efficiency methods of compensation and is not to be considered under traditional day rate.

Ordinary Piece Rate

The principle of the piece-rate system, which proclaims pay for measurable results rather than for time service, would at first sight seem to indicate the substitution of free contract for paternalism and vassalage. If employers were always fair and workers always reasonable, ordinary piece rate would be mathematically fair. The

system has been so badly abused, however, that there is a tremendous prejudice against it. It has come to be associated with the sweat-shop system where the cupidity of the employer sets the piece rates so low that only excessively long hours and high speed enable the worker to eke out an existence.

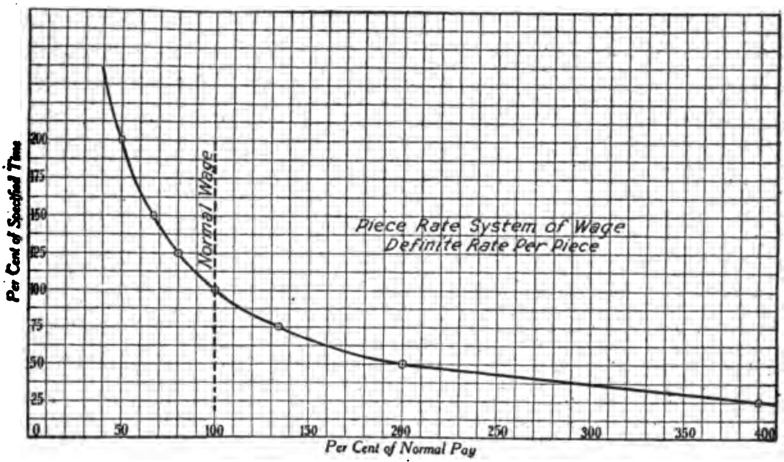

Fig. 67.—Chart Illustrating How Normal Pay Increases with Increased Output and Decreases with Lessened Output Under Ordinary Piece Rate

Piece rate has been used as a bait to speed up employes to a certain pace and then, when that pace was reached at which a certain class of workers earned more pay than the proprietorship considered they were worth, the rate was cut. After several such cuts the system produced nothing but fear and hostility together with intentional loafing on all new work, so as to get the piece rate set as high as possible, since it was bound to be cut. If piece rate is to be used at all, it must be accompanied by a guarantee that there will be no change in the

rate so long as methods, tools, and machines are not changed.

When time reductions are in no way the result of effort on the part of the employe, a change in rate cannot be called a cut. For example, the introduction of high-speed tool steel enabled machine-tool operators to run their lathes so as to have a surface speed from two to three times as great as had been possible under former conditions with the use of carbon tool steel. A doubled output was easily obtainable without the workman's being compelled to exert himself any more than with the old steel. On the other hand, the company, under these circumstances, can afford to pay a piece rate slightly in excess of one half the former piece rate, since there is likely to be also a saving in view of the fact that a larger quantity of output is turned out without a correspondingly greater increase in the overhead rate or manufacturing expense. Figure 67 shows how normal pay increases and decreases under ordinary piece rate.

Differential Piece Rate

The differential piece rate consists of two rates: (1) the ordinary piece rate, which is paid a man for a normal or ordinary output, and (2) a higher rate, which is paid per piece, if a man turns out more than an ordinary output. It is quite apparent that the reasoning in the case of differential piece rate is entirely different from that which resulted in cuts under the traditional piece-rate methods. Under the differential piece-rate system the workman not only has no fear of the rate's being cut, but he has a tremendous incentive to earn high pay, in view of the fact that he receives an exceptionally high reward for accomplishing good results.

For example, assuming that, as the result of time study and the building-up of an instruction card, it is shown that a piece of work can be done in 30 minutes. In order to allow for necessary rest periods and avoid lost time, 60 per cent is added to the possible time, an increase of 18 minutes as an incentive, making 48 minutes the normal or average man's time. In an eight-hour day we should have 480 minutes; hence, the normal average output of an ordinary man would be ten such pieces. Under the differential piece-rate system there would now be two rates offered, say, for example, 30 cents per piece for an output of ten or less, and 35 cents per piece for an output of more than ten. It will be seen, therefore, that if the man produces ten pieces, his earnings for the day would be $3.00, whereas, if he turns out eleven pieces, his earnings rise to $3.85.

It is argued that this system would tend to make a man exert himself beyond the limit of good health. In reply to this we can say that the man has an instruction card showing that the work can be done in 30 minutes, so that, without any rest periods whatever, the output would be sixteen pieces in an eight-hour day. The workman is given instructions in regard to the percentage of rest periods applicable to each class of work.

Assuming this to be lathe work, he is told that the total of rest periods should aggregate 20 per cent of the time. Of course, it is possible to take some of these rests while the tool is doing work; hence, it would be entirely possible to turn out thirteen or fourteen of these pieces in a day with abundant time allowance for rest. The company can afford to offer the increased piece price, because the cost of operating a machine tool, including power, light, heat, rental for floor space, tools, oiling, repairs, etc., is likely to be as great as the rate of the mechanic who is operat-

ing the machine, and the day rate of the machines remains very nearly stationary while the output increases. Figure 68 shows how under the differential piece rate the pay per piece increases at a more rapid rate as time is reduced than under ordinary piece-rate.

This last point may be illustrated mathematically. Let us assume in the above case that the cost of operating the machine is 35 cents an hour. The formula for determin-

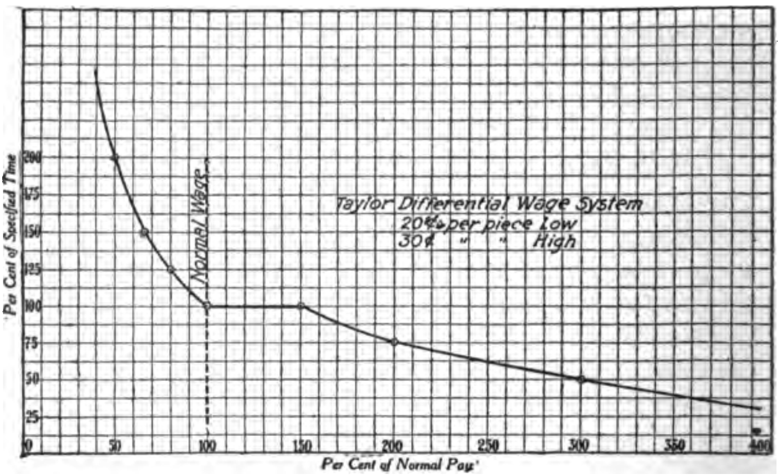

FIG. 68.—Chart Illustrating How Pay Increases Under Differential Piece Rate at a More Rapid Rate as Time Per Piece is Reduced than Under Ordinary Piece Rate

ing the direct labor and machine cost per piece will be:

$$\frac{\text{Machine rate} \times \text{hours} + \text{piece rate} \times \text{number of pieces}}{\text{Number of pieces}} = \text{Cost per piece}$$

If a poor workman, then, turns out only eight pieces during an eight-hour day, the cost per piece then will be:

$$\frac{35 \times 8 + 30 \times 8}{8} = 65 \text{ cents}$$

If, on the other hand, a workman turns out eleven pieces, the cost per piece will be as follows:

$$\frac{35\times8+35\times11}{11}=60\tfrac{1}{2}\text{ cents}$$

You will observe that in the first case the workman earns $2.40 per day and the cost to the employer is 65 cents per piece. In the second case, the workman with his higher piece rate earns $3.85 a day, while the cost per piece to the employer is only 60½ cents. This illustration shows how both employer and employe may profit under a properly adjusted wage system of this kind.

Collective Contract Work

Where work is repeated over and over again in considerable volume, the practice exists of making a contract with competent workmen whereby they are to furnish a certain number of pieces at a specified price. Under this arrangement the contractor employs his own men, while the company furnishes the material, buildings, equipment, and tools.

This contract system is quite generally employed in several of our larger locomotive shops. An inspection of these shops indicates that there is considerable loss due to the contractor's requisitioning more material and finished parts than he actually requires, so that there is an accumulation of surplus parts which have to be returned to stock, or made over, if possible, or scrapped. The contractor claims that these overdrafts are necessary because of the possibility of defects or poor fits. It is also claimed that the contractors are careless with the company's tools and machines. The only satisfactory reason for the employment of collective contract work seems to

be that organized labor will submit to a brisk pace when imposed upon its members by a contractor who is himself a member of the organization.

It is quite apparent that fear of cutting the contract price will operate with the contractor in just the same way as it does with the workman under the traditional piece-rate system. The contractor will feel that, if the management thinks he is making too much money, it will not give him the same price on the next contract; hence, he dare not turn the work out at a rate so rapid as to yield an exceptional profit.

Time Work with Efficiency Records

As previously stated, the crudest type of day work is that in which the workmen are paid a uniform class rate, regardless of individual efficiency. As soon as we have accumulated data with regard to standard elementary times, and the correct total time in which various jobs should be done, we can establish a record for every employe in which the time he took under the day-rate system is compared with the time standard established. If the total hours which he spent on standardized work are recorded, and the sum of these standard times is divided by the time which he actually took, we shall get a percentage which roughly approximates his efficiency on standardized work. For instance, if during a certain week a man has had jobs on which time standards have been established to the extent of 30 hours of work according to the established standards, and the time it actually took him to do these jobs was 40 hours, then his approximate efficiency was $\frac{80}{40}$, or 75 per cent.

If we have accumulated records of this sort covering the performance of a number of workmen, we shall soon

find that we have certain good workers who turn out regularly from two to three times the quantity of work done by poor ones. It is immediately apparent that a company can afford to increase the efficient worker's rate gradually until it is one-third, or more, higher than the former average rate, simply for the purpose of retaining the high-grade man. At the opposite end of the scale the efficiency record will soon disclose what workers are uniformly inefficient. These should receive instructions with a view to bettering their efficiency. If they do not show themselves willing to better their efficiency, they should be dismissed with the least possible delay.

Under a combined day-rate and efficiency-promotion system of this sort advances may be made at intervals of from three to six months in the hourly rate of the employe until he reaches the maximum rate. This system will gradually attract the good workers of a vicinity to the establishment, since they know that they will receive good wages. The poor workers will be rapidly weeded out, and the news will be spread that poor workers are not wanted in the establishment. The only difficulty in connection with this system is that, in case organized labor is employed, an amicable agreement should be made at the outset whereby the organization will agree not to demand that the maximum rate be paid all of its members, and that they will countenance the discharge of members whose efficiency records show them to be unfit.

Halsey Premium System

In the premium system as devised by Mr. F. A. Halsey the workman receives his hourly rate, and in addition to this receives extra pay every time he does the work in less

time than the time standard. The time standard originally employed by Mr. Halsey was the average of the records of previous performance. At the present time, however, the time standard is usually taken from 40 to 60 per cent higher than the time in which a skilled workman can do the work under correct conditions, such time standards having been established by a scientific motion and time study made during demonstrations by a skilled

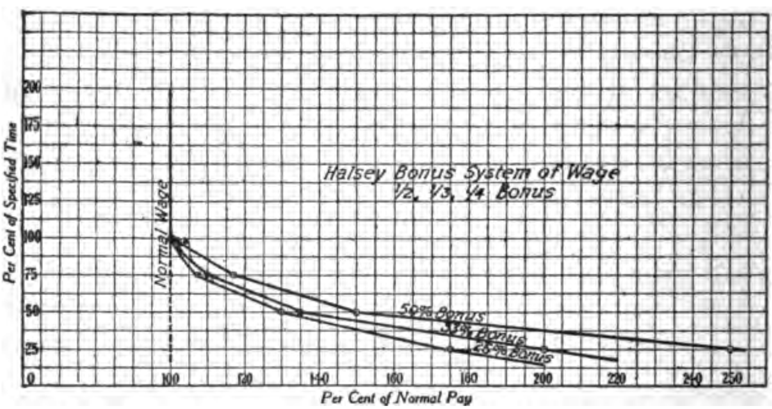

Fig. 69.—Chart Illustrating How Pay Per Piece is not Reduced if More than Specified Time is Consumed and How Pay Increases as Time is Reduced under the Halsey Premium System

mechanic. The method of figuring wages under the Halsey premium system is expressed in the following equation:

Wages = the time taken × the hourly rate + the time saved × a fraction of the hourly rate

The customary fraction of the hourly rate is 50 per cent. Prior to the general acceptance and introduction of accurate motion and time study made on demonstration

by skilled mechanics as a basis of time standards, various systems were used which sought to establish a diminishing premium scale as the time was reduced below the time standard. These systems sought to provide a sort of insurance for employers who made mistakes in setting their time standards too high.

The 50 per cent gain-sharing rate is not advocated by Halsey as absolutely the only rate to use. In fact, he recommends the use of lower premium rates for certain classes of work in which the workman does not have to exert himself, or exercise unusual intelligence or skill in order to earn a premium. As the extra pay or premium for time saved, he recommends the use of varying percentages of the value of the time saved, running from fifty down to as low as twenty.

Some of the results actually obtained under the Halsey Premium Plan are analyzed in the following table:

Time Allowed	Time Taken	Wages on Job at 30c an Hour	Premium 33 1/3 % of the Value of the Time Saved	Workman's Earnings per Hour	Total Labor Cost of Job
10 hours	10 hours	$3.00	0	.30	$3.00
10 hours	9 hours	2.70	.10	.311	2.80
10 hours	8 hours	2.40	.20	.325	2.60
10 hours	7 hours	2.10	.30	.343	2.40
10 hours	6 hours	1.80	.40	.366	2.20
10 hours	5 hours	1.50	.50	.40	2.00

The field for premium systems is in such manufacturing establishments as make a line of various styles and sizes of product, in which part of the work is repetitious and part of it interchangeable, while a large portion represents parts which are made only once or at long intervals.

The premium system has the advantage that it does not set up fear as an incentive. Absolute guarantee should be made of the principles of time standards under the premium rate system, so long as methods, tools, and machines are not changed.

The premium system, like all other systems which are different from day rate, is in many localities opposed by local labor unions. Some labor unions thoroughly discredit the practice of more than one rate of wages. Testimony before the Industrial Commission indicates that in some localities, if a man is known to accept pay beyond the regular rate, he is said by his fellow union members to be taking blood-money, and is despised as much as a man who works below the standard rate. Figure 69 shows how normal wage is paid if time per piece is not reduced, and how pay increases as time is reduced under the Halsey Premium System.

Rowan Premium System

This is a modification of Halsey's premium system, devised by Mr. James Rowan, a member of a well-known Scotch engine establishment. Time limits are established as under the Halsey system. The amount to be added, in case the time limit is reduced, is figured in the following manner: The premium equals the money value of the time actually taken to do the job multiplied by the time saved and divided by the time limit. For example, if the time limit is 10 hours for a piece of work on which is employed a man receiving 30 cents an hour, and he does the work in 8 hours, then his pay will be 8 times 30, or \$2.40, for his regular time; the premium to be added will be $\frac{2 \times 2.40}{10}$, or 48 cents.

Further results of the application of the Rowan Premium System are exemplified in the following table:

TIME ALLOWED	TIME TAKEN	WAGES ON JOB AT 30c AN HOUR	PREMIUM MONEY VALUE X PER CENT OF TIME SAVED	WORKMAN'S EARNINGS PER HOUR	TOTAL LABOR COST OF JOB
10 hours	10 hours	$3.00	0	.30	$3.00
10 hours	9 hours	2.70	.27	.33	2.97
10 hours	8 hours	2.40	.48	.36	2.88
10 hours	7 hours	2.10	.63	.39	2.73
10 hours	6 hours	1.80	.72	.42	2.52
10 hours	5 hours	1.50	.75	.45	2.25

An investigation of the accompanying table and curve, as well as the trying out of actual figures in the formula given, will show that, no matter how far the time is reduced, the premium will never be quite as great as the regular pay at a given time, so that the man can never double his wages under this system.

The Rowan system is used to a considerable extent in Great Britain. Objections have been made to it on the ground that there ought to be no limit to the amount of premium or bonus which a man can earn. In reply to this the statement is made that the management may have a very definite idea of the shortest time in which it is desirable to do a piece of work from considerations of accuracy, wear of machinery, and fatigue affecting the man. Another objection to the system is that it requires a higher grade of clerical help to figure out the premium than is needed with the Halsey system, also that figuring the premium is too complicated an affair for the workman, and that he will therefore become dissatisfied. Where the clerical labor and the mechanics are both of a high order of intelligence, these last objections will not

hold good. There are conditions, however, under which they will be valid. Figure 70 shows how pay remains the same if the time is not reduced, and how it increases as the time is reduced under the Rowan system.

Gantt Bonus System

In this system as originally devised by Mr. Gantt, the workman is paid an hourly rate, irrespective of the time it takes him to do his work. Time standards, however,

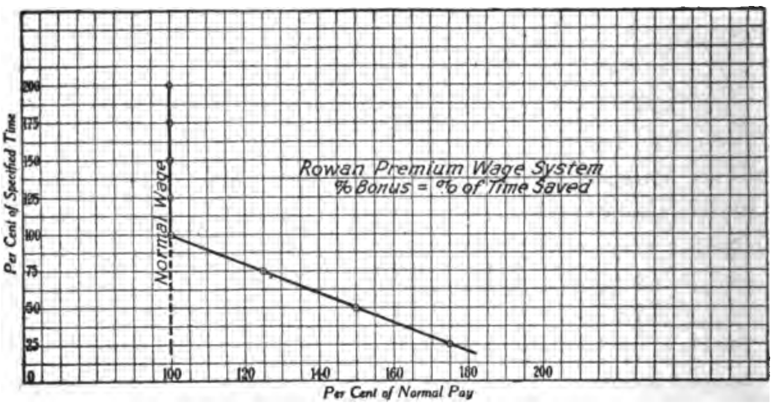

Fig. 70.—Chart Illustrating How Pay Remains the Same if the Time is Not Reduced and How It Increases as the Time is Reduced under the Rowan System

are established for every job, and if the workman does all the work called for in a given day within the time standards established, he receives a fixed daily bonus in addition to the day rate. In this system the foreman is also paid a bonus each day for each man who earns a bonus. It will be noted that reward is provided for the man attaining 100 per cent efficiency, on all jobs in a given day. In case he "falls down" on any job in a day, there is no incentive for him to strive to do the other

jobs in as short as possible a time, since he knows he has lost his bonus for the day. Figure 71 shows how day rate is paid irrespective of output and how pay increases as time is reduced under the Gantt bonus system.

Bonus System on Individual Jobs

In this system the workman is paid an hourly rate and in addition is given a bonus on each job done within the standard time, such bonus being expressed in a percent-

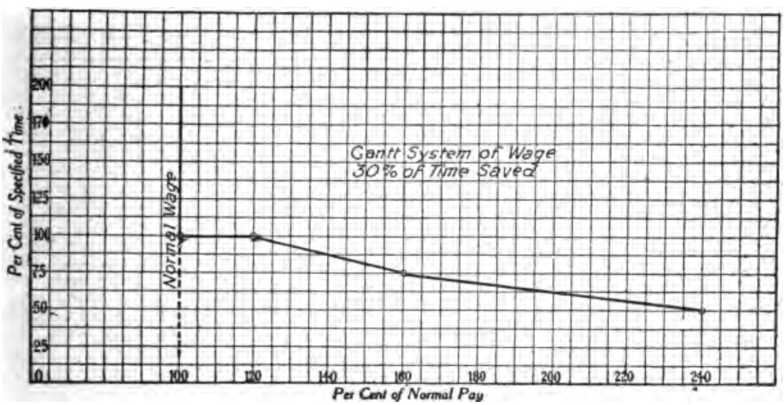

Fig. 71.—Chart Illustrating How Day Rate is Paid Irrespective of Output and How Pay Increases as Time is Reduced under the Gantt Bonus System

age of his wages, or as a definite sum of money varying with the nature of the job and time spent. The amount of the bonus may be determined by various methods. As an example of this system we may establish the time standard of the job as 10 hours, and we may specify as bonus the amount which we shall pay for reducing this time standard by varying amounts as follows: If work is done in 9 hours, bonus is 15 cents; if work is done

in 8 hours, bonus is 40 cents; if work is done in 7 hours, bonus is 70 cents, etc.

The particular field for this bonus system would be in industries in which the standards had become pretty well established under the original Gantt bonus system. A further development of this system is that of paying to the foreman a differential bonus varying with the number of men in his department. For instance, assuming that he had ten men under him, he would get 10 cents per

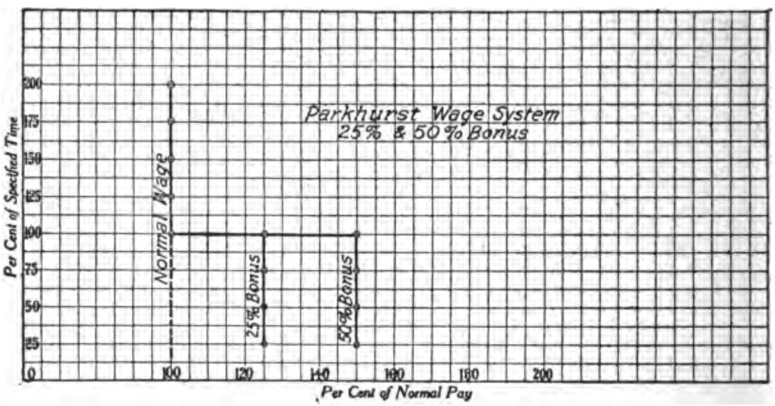

Fig. 72.—Chart Illustrating How Pay on the Individual-Job Bonus System Increases as the Time is Reduced

man bonus, or $1.00 per day, if nine of his men made their bonus. If, however, all his men made their bonus he would receive 15 cents per man, or $1.50. This system applies the differential price rate for rewarding foremen. There is an inducement for him to secure the highest efficiency from every workman.

It will be noted that the individual job bonus system recognizes 100 per cent efficiency on the individual job, but does not reward a man for his effort, in case he does

not attain 100 per cent efficiency. The payment of bonus on individual jobs demands a high grade of accuracy and integrity on the part of the person keeping the time record, so as to prevent the robbing of time from one job and putting it on another in order to favor the working men. Moreover, the most desirable employe is not the one who makes gains by occasional spurts, but one who averages high in efficiency. Under the individual-job bonus system there is no incentive to maintaining a uniformly high efficiency on all jobs. Figure 72 shows how pay on individual-job bonus system increases as time is reduced. The data used are from bonus charts prepared by Frederick W. Parkhurst.

Diemer Combined Bonus and Premium System

The writer introduced in 1905 at the Atlas Engine Works at Indianapolis a system in which the workmen were paid a 10 per cent increase of their wages if they reduced below past average the time in which the work was done. They were paid 20 per cent of hourly wage increase if the work was done in a specified standard time, such standard time being based on motion and time study, on demonstration by skilled mechanics, and about 30 per cent being added to this time. A further so-called "gain-sharing bonus" on the Halsey premium plan was allowed if they did the work in less than the specified standard time. In addition to the bonus wages paid, a record was kept of every man's percentage of success during each pay period, and each man's percentage of success under the system was made the basis of promotion in his hourly rate.

The field for this system is the same as that for the bonus system. Its particular advantage lies in the fact that, recognizing the tendency of men to work in spurts

on certain jobs, it offers inducements to men who are faithful and steady in their efforts to do every job in the standard time. This system was described in the Engineering Magazine for August, 1905. Figure 73 shows how with guaranteed day rate the pay increases as time is reduced under this system.

Efficiency System

In this system a standard time is established for each job. During each pay period a record is made of the

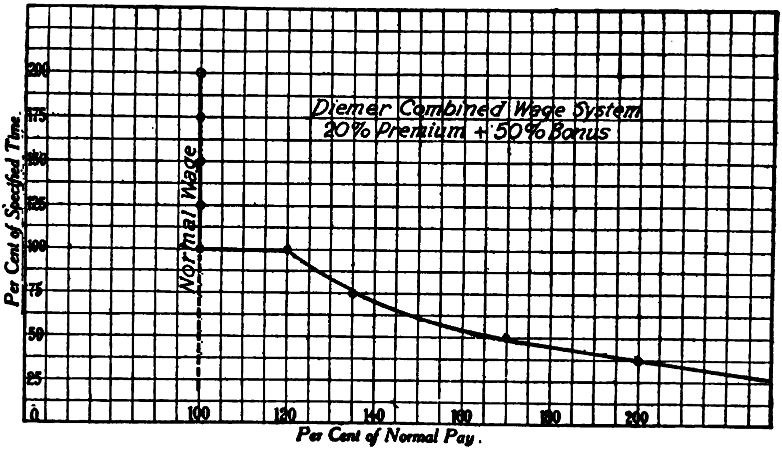

Fig. 73.—Chart Illustrating How with a Guaranteed Day Rate the Pay Increases as the Time is Reduced under the Diemer Combined Bonus and Premium System

number of hours a man worked on the jobs on which time standards were established. Then the total hours in which he did these standard time jobs is divided into the total sum of the time standards. For example, if the sum of the standard times in a given pay period aggregates 210 hours, and the man took 240 hours on these jobs, then his efficiency would be $\frac{210}{240}$, or 87.5 per cent.

Mr. Harrington Emerson devised a sliding-scale for determining the bonus to be paid under the efficiency system. This scale is as follows:

PER CENT EFFICIENCY	BONUS AS FRACTION OF WAGES
66.0	.0001
68.0	.0004
70.0	.0020
72.0	.0055
74.0	.0101
76.0	.0161
78.0	.0239
80.0	.0330
82.0	.0435
84.0	.0555
86.0	.0693
88.0	.0840
90.0	.1000

Above 90 per cent efficiency add the percentage above 90 to 10 per cent and the sum is the fraction of the wages to be paid as bonus. Figure 74 shows how with guaranteed day rate the Emerson system rewards for increased efficiency. Figure 75 tabulates methods of calculating the data from which the preceding curves were plotted.

Selecting and Introducing Wage Systems

The type of wage system to be introduced will depend not only on the extent of standardization, but also on whether the workmen are of a high or low grade of intelligence, and whether or not they are under the domination of strict union regulations in regard to wages. A good many writers introducing wage system suggest the Halsey premium system as a transitional plan to be used where time studies have not been introduced. While it is true that the premium plan, as in-

stalled in the early 90's made use of the past averages of time performance, as shown by time tickets and cost records, we must bear in mind that Mr. Taylor's first paper describing time study methods was presented before the American Society of Mechanical Engineers in 1895.

Systematic time study, in accordance with Mr. Taylor's recommendations, was taken up by a great many

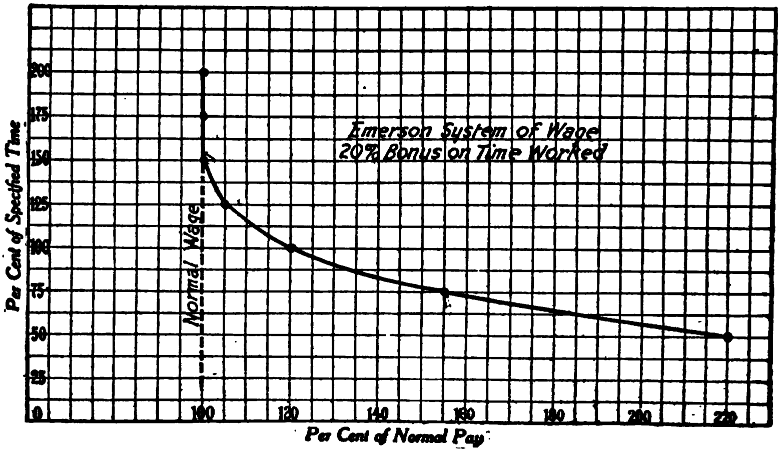

FIG. 74.—Chart Illustrating How with Guaranteed Day Rate the Pay Increases as Efficiency Increases under the Emerson Efficiency System

competent engineers and shop managers outside of the circle of Mr. Taylor's immediate associates. Among the machine-tool builders in the Cincinnati district time study took the place of past averages in the late 90's. It was realized by these machine-tool builders that standardization and time studies were essential preliminaries to any successful wage system. Moreover, they also realized that bonus and premium rates must be specially established for each distinct machine or

VARIOUS SYSTEMS OF WAGE REDUCED TO A UNIFORM NORMAL PAY ON AN 8-HOUR JOB AT 20c PER PIECE OR 8 PIECES PER DAY AT 20c PER PIECE, 8 HOURS MAKING A WORKING DAY

% OF SPECIFIED TIME ACTUAL TIME IN HOURS	25 2	50 4	75 6	100 8	125 10	150 12	200 16	METHOD USED IN CALCULATIONS
Time rate	40	80	120	160	200	240	320	Straight 20c per hour
Piece rate	160	160	160	160	160	160	160	Straight 20c per piece
Halsey ¼ bonus	70	100	130	160	200	240	320	¼ of time saved
Halsey ⅓ bonus	80	107	133	160	200	240	320	⅓ of time saved
Halsey ½ bonus	100	120	140	160	200	240	320	½ of time saved
Rowan premium	70	120	150	160	200	240	320	% bonus = % time saved
Taylor differential	240	240	240	160	160	160	160	High: 30c piece; low: 20c piece
Gantt bonus	192	192	192	192	200	240	320	30% of time saved
Emerson bonus	168	176	184	192	210	240	320	Time saved plus 20% premium on time worked
Diemer premium bonus	108	136	164	192	200	240	320	50% time saved plus 20% premium on time worked
Parkhurst 25% bonus	50	100	150	160	200	240	320	Day rate plus 25% bonus
Parkhurst 50% bonus	60	120	130	160	200	240	320	Day rate plus 50% bonus

FIG. 75.—Tabulation Showing the Method of Calculating the Data from which the Preceding Wage Curves Were Constructed

method, and that an iron-clad guarantee must be given that the rate once established will not be cut, and this guarantee must be faithfully lived up to. In general, we may state the field of the various systems as follows:

Where standardization has not been developed very far, time work with efficiency records is appropriate.

Where standardization is under way, but has not been very well developed, the premium system is applicable.

Where standardization is fully developed, the bonus system on individual jobs, the combined bonus and premium system, or the efficiency system may be introduced. Various systems may be introduced in the same shop. At the Link Belt Engineering Company, in Philadelphia, some of the work is ordinary piece rate, some on differential piece rate, some on premium rate, and some on individual-job bonus.

TEST QUESTIONS

1. Into what three general groups may we classify wage systems?
2. What are the disadvantages of time work?
3. How may time work be made most effective?
4. What are the objections to ordinary piece rate?
5. Describe the differential piece-rate system.
6. Describe collective contract work.
7. How may time standards and efficiency records be applied to a time-work system?
8. Describe the Halsey premium system.
9. Describe the Rowan premium system.
10. Describe the original Gantt bonus system.
11. Describe the bonus system as applied to individual jobs.
12. Describe the Diemer combined bonus and premium system.
13. Describe the Emerson sliding scale and efficiency system.

14. Discuss the question of selecting the proper wage system for various conditions.

15. What remedy would you propose to do away with "soldiering" or loafing?

16. In case new equipment or new methods promote time reductions for which the worker is not responsible, how would you endeavor to justify to his satisfaction the lowering of piece rates or premium times?

17. Under the Halsey and other premium systems do you think it is fair that the proprietorship should retain half of the value of the time saved by the worker? Give reasons for your answer.

18. Under a day-rate system with efficiency records, what course should be pursued with regard to the men showing the lowest efficiency?

19. How would you explain the attitude of organized labor favoring a uniform wage scale and opposing any type of extra compensation based on individual efficiency?

20. What are the preliminary steps in connection with organization and system which must be taken before the wage question can be considered?

CHAPTER XV

WELFARE AND BETTERMENT WORK

Aims of Welfare and Betterment Work

Strength, both physical and moral, happiness, contentment, thrift, industrial and social intelligence among workers as well as supervising forces, are the aims of modern industrial welfare and betterment work. When intelligently undertaken and systematically carried on, such work will result in as marked an advantage to the employer as the result from well-organized planning and standardization. The closer relationship established between employers and employes develops interest and enthusiasm to such an extent that increase in efficiency, as regards quality and quantity of output and avoidance of wastes, more than pays for the expenses connected with welfare undertakings.

Naturally there will be some failures from suspicion and from ingratitude, no matter how intelligently and unselfishly welfare and betterment work is undertaken. It is nevertheless true that, if a company wishes the most competent and intelligent men, it is essential to provide the most inviting surroundings and conditions, since intelligent and thrifty men will naturally seek an intelligent and wholesome environment in which to work.

In order to carry the work as far as possible, and at the same time avoid the charge that the employer is paternalistic, it is necessary that the workmen them-

selves carry on the management of the work, the employer furnishing only the suggestions and inspiration. It follows necessarily that the work cannot be hurried. If some of the men are opposed to certain results, or scoff at them, it is sometimes best to put them on a committee to carry out these measures, with a diplomatic foreman or superintendent on the same committee.

Activities Included Under Welfare and Betterment Work

The activities coming under this general head may be grouped into those relating to:

1. Safety and accident prevention.
2. Education.
3. Rest periods and luncheons.
4. Social.
5. Medical.
6. Physical training.
7. Suggestions.
8. Benefit societies.

Organization for Welfare and Betterment Work

The greatest success has been achieved where questions of safety, welfare, and betterment have been referred to committees composed not only of engineers and higher officials, but of workmen and foremen and even outside persons. In so far as certain features of safety problems are mechanical, certain uniform standards can be adopted, but even the safety problem is only to a small degree mechanical.

As the problem is very largely a human one, conditions will be widely different. The manufacturer who copies what others have done in safety, welfare, and betterment work will find that he is attacking his own

problem in no more satisfactory a manner than if he were to adopt the factory accounting forms of some other establishment. He may get some useful suggestions from the work done by others, but he will have to apply his own initiative (and that of such members of his force as show ability in this direction) towards developing methods suitable to his particular problems.

The ordinary form of organization is to have a permanent committee, consisting of a chairman, who is generally selected from the engineering or works management division, with two or three other members, usually of foreman's rank. This committee should hold monthly meetings regularly and such special meetings as may be necessary. The duty of this committee is to pass upon all recommendations and make such inspections as are necessary in connection with recommendations.

In addition to the permanent committee, workmen committees are appointed. These men are chosen among the workmen holding lower rank than assistant foreman. In some industries good results have been obtained by having these men serve a month, and appointing them fifteen days apart, so that there will always be a man of some experience with a new man on a committee. These men are instructed by the chairman of the permanent committee. If on safety work, they make inspections once a week and turn in their reports to the permanent committee, which acts on their recommendations either favorably or adversely. The aim of having the workmen's committees is to secure as widespread an interest in the work as possible.

Besides the permanent committee and workmen committees, in case a plant is large enough, a permanent safety, welfare, and betterment man may be employed to give his entire time to supervising the work.

The organization for welfare work at the Cadbury Works, at Bournonville, one of the best examples in the world, of successful work of this sort, is as follows:

All welfare and betterment work is under the jurisdiction of a works committee. There are four divisions of this committee, namely:

1. The works education committee.
2. The men's works committee.
3. The girls' works committee.
4. Suggestion committee.

The general committee meets on Monday mornings. There are sub-committees of the men's works committee dealing respectively with holidays, accidents, gardens, benefits, recreation grounds and buildings. The girls' works committee deals with promotions to staff, examinations, plans of additional buildings and extensions, investigates complaints and accidents, maintains fire drills in the girls' departments, and makes periodical inspections of dressing-rooms, dining-rooms, kitchen, baths, gymnasiums, store-rooms, etc. They also periodically inspect the girls' recreation grounds.

Safety, Accident and Fire Prevention

The installation of proper accident and fire prevention apparatus is beneficial from several points of view. It does away with loss to the proprietorship in the way of actual fire damage and interference with business in case of fire. It prevents many losses due to compensation for unavoidable accidents and injuries, as well as the litigation that arises out of them. But equally important is the fact that it tends to do away with fear on the part of the employes, develops a kindly attitude, and thus assists to increase output.

In factories it is necessary that sheet metal or cast aluminum guards, so constructed that they can be easily removed, be placed over all exposed gears. Proper screening, preferably made of expanded metal somewhat heavier than wire mesh and supported on pipe frames, should be placed around all moving belts to a height of 4½ feet from the floor level. Overhead belts should have guards underneath them, so that in case of a break they will not whip around.

Punch presses should be equipped in such a manner that they will not operate until the workman's hand is withdrawn from a position which would endanger him. Guards should be provided over all saws or cutters in woodworking machines, and substantial fences should be furnished for operators at band-saws and similar machines where the workman is exposed to danger in spite of the best modern safety devices. This fence is to prevent the workmen from being jostled by anybody else.

Dust exhaust systems must be provided in all woodworking shops, around grindstones, emery-wheels, buffing-wheels, and polishing-wheels, so as to carry off dust and small particles, which are injurious to the health of workers.

Detailed methods for safeguarding practically every kind of machinery are furnished at the present time by the various compensation insurance companies, and by the bureaus of labor, industry, and compensation established as state departments in a number of states.

As regards fire prevention, the principal remedial steps to be taken are:

1. The providing of ample fire escapes.
2. Automatic sprinklers with an abundant supply of water independent of the ordinary system.

3. Chemical extinguishers.
4. Fire hose at sufficiently close intervals to be effective.
5. Water-buckets and sand-buckets kept filled and available for immediate use.
6. Metal cans with self-closing lids to receive oily waste and any other inflammable material.
7. Fire drills among employes.
8. Shop fire companies.

The various fire underwriters' bureaus have available detailed descriptions of fire prevention apparatus and building specifications for various kinds of industrial establishments, which should be carefully consulted by committees having this subject in charge. Figures 76, 77, 78, and 79 illustrate typical modern machine safeguards.

Under the existing apprentice systems at the General Electric and Westinghouse companies, it costs those corporations about $1,000 over and above the value of the productive work of the apprentice to make him a valuable worker. If an accident occurs to this apprentice the company loses, therefore, an investment of $1,000, in addition to any liability for damages. Moreover, they must start over again, expending not only the money but the time also in training another apprentice.

For the ordinary factory without safeguards the average rate of insurance for compensation for accidents is about $2.50 per $1,000 of pay-roll. With proper safeguards this rate can be cut in half. The most hazardous industries in order of greatest number of accidents happening per annum are as follows:

1. Metal mining.
2. Coal mining.

3. Fisheries.
4. Navigation.
5. Railroads.
6. Electricians.
7. Building construction.
8. Street railroads.
9. Telephone and telegraph men.
10. General manufacturing.

The most common causes of accidents of all sorts in all of the above industries are as follows:

1. Hand tools and hand apparatus.
2. Objects falling from piles.
3. Hoisting and moving objects.
4. Power-driven saws.

As indicating the effect of proper illumination in preventing accidents it is interesting to know that the number of industrial accidents increases rapidly as the days shorten. By far the highest number of accidents occur in the middle of December, and by far the smallest number in the middle of June.

One must not expect the complete elimination of accidents in the first year of installing safeguards and organizing for safety work. However, in the Pennsylvania Railroad Company the number of accidents was reduced to 63 per cent of what they had been prior to safety organization at the end of one year in a shop group employing 33,000 men. The Cadillac Motor Car Company reports a reduction of 64 per cent in the number of accidents at the close of its first year's safety organization in a shop employing about 3,000 men. The Pullman Company gathered statistics as to the time lost by reason of accidents and found that at the end of one year's safety

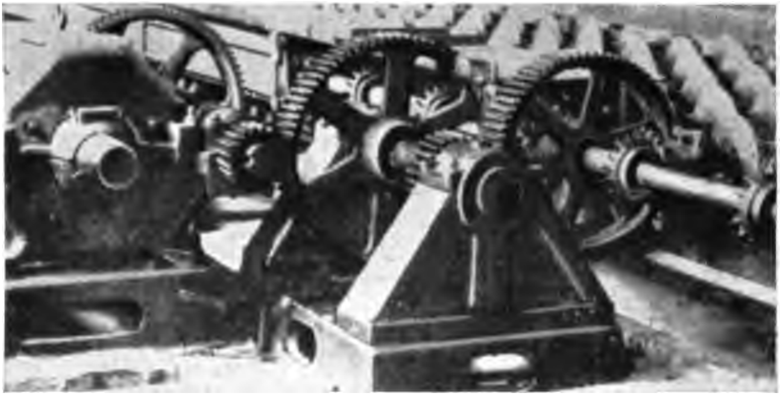

FIG. 76.—Transfer Table, Motor Gears Uncovered
U. S. Steel Corporation

FIG. 77.—Transfer Table, Motor Gears Covered
U. S. Steel Corporation

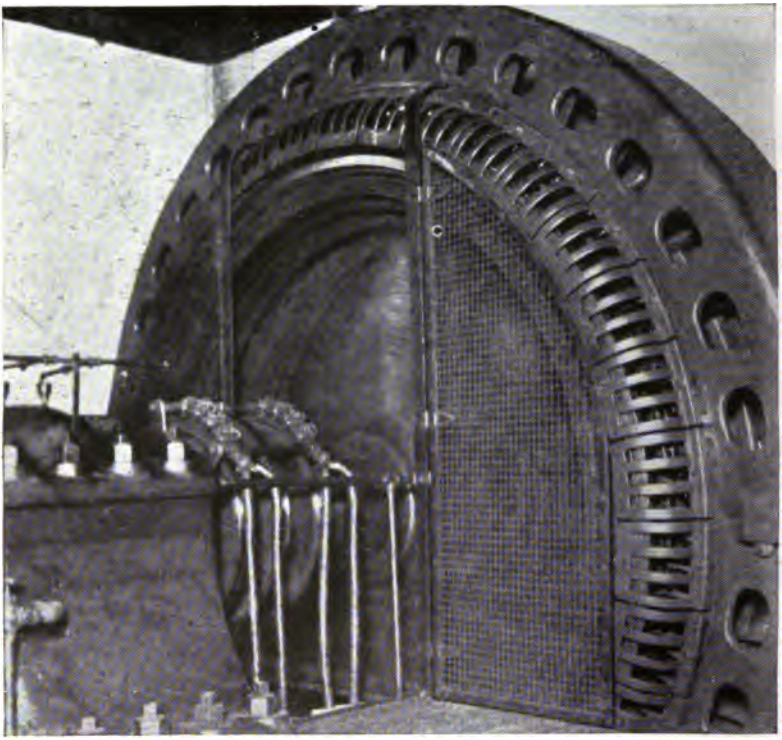

Fig. 78.—Method of Guarding a Mill Motor
U. S. Steel Corporation

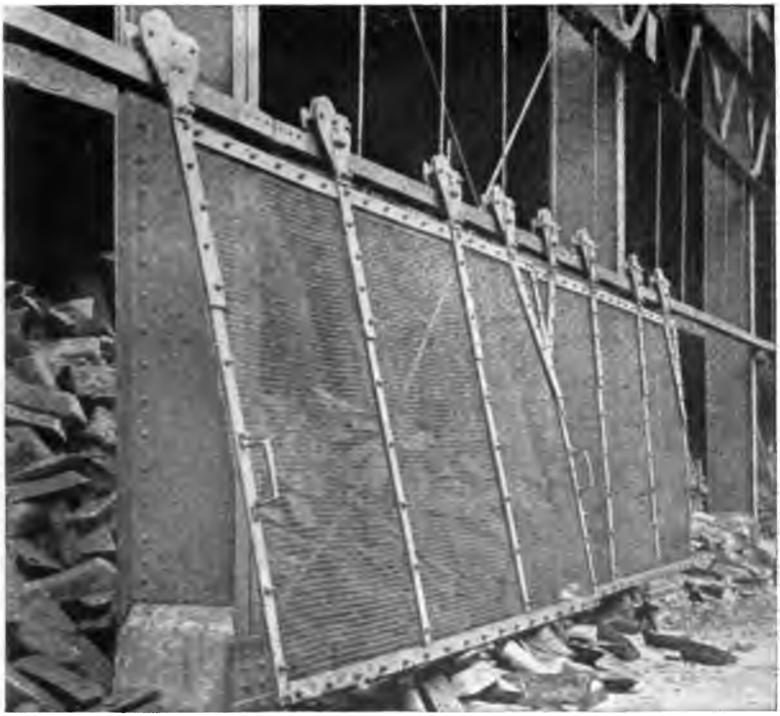

FIG. 79.—Pig-Iron Trestle Shield to Prevent Flying Chips from Pig Iron Injuring Workmen
U. S. Steel Corporation

FIG. 80.—Gardens—American Bridge Company, Ambridge, Pa.
Land is owned by the American Bridge Company, laid out in plots and allotted to their employes for raising garden truck. About sixteen acres are under cultivation by them.

FIG. 81.—Bird's-Eye View of Town of Marguerite

FIG. 82.—Group of Slavish Laborers Who are Stockholders
Clairton Steel Works, Carnegie Steel Company

FIG. 83.—Swimming Pool—Leisenring No. 1 Mines
H. C. Frick Coke Company

FIG. 84.—Playgrounds, National Tube Company

FIG. 85.—Playgrounds, National Tube Company

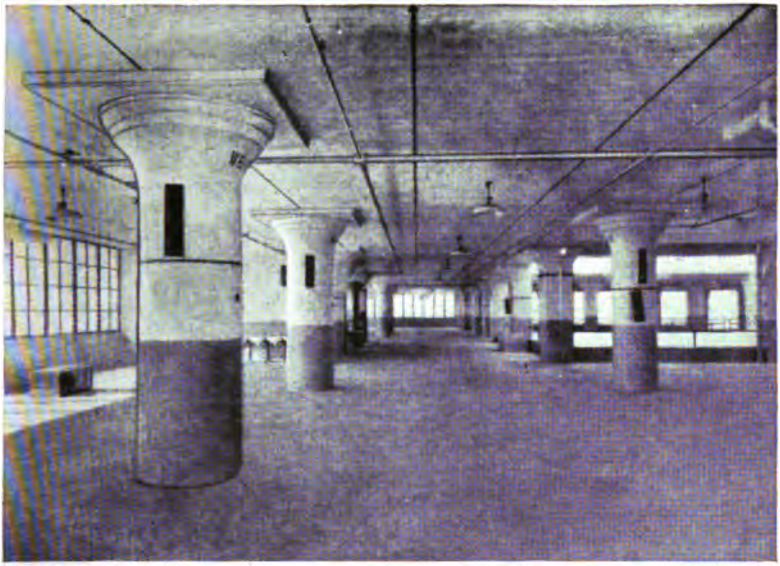

Fig. 86.—Photograph Showing the Location of Column Ventilators at the Ford Motor Works

Washed and humidified air under pressure enters through the openings in the columns.

FIG. 87.—Emergency Hospital, Continental Works, National Tube Company

organization they reduced the average lost time per employe, by reason of accidents, 14 minutes per year—from 48 minutes to 34.

Educational Activities

These will include instruction in trades and processes of the industry, technical and scientific training relating to the industry, business and accounting, principles of economics, sociology, and citizenship. Where the establishment is large enough to introduce a corporation school of its own, information as to organizing and carrying on such a school can be obtained from the Proceedings of the National Association of Corporation Schools, in regard to which Mr. C. R. Dooley, of the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., or the Secretary, Irving Place and Fifteenth Street, New York, can give information.

Local school superintendents in industrial centers and state departments of education in many states have available information as to how to organize vocational, continuation schools and night schools. Where a business is not large enough to justify local corporation schools, general classes can be organized. In some states the state will defray a part of the expenses of conducting such schools.

Even a small industry will find it desirable, however, to supplement the work of such general schools by special training for the company's own work. The simplest beginning is a series of lectures by members of the sales and engineering staff. After these members have lectured, it is usually possible to persuade the superintendent and some of the foremen to take part in the lectures. Members of the sales departments of companies which supply machinery and material to the in-

dustry may also be called in as well as local factory and insurance inspectors. The most effective results are naturally obtained through the training of the apprentices, who obtain thus at an early age an unbiased and intelligent industrial and economic attitude in consequence of their training in the apprentice school. Among other educational activities are the small shop or traveling libraries adapted to industrial needs.

The co-operation of local library and state traveling library officials can be secured, and in some cases they will provide a speaker to accompany the books to the shop the first time and talk on the value of good books and reading. The home reading-box is a box in which various employes place periodicals, bulletins, and books which they have read and are willing to pass on to others. The classes for non-English-speaking men and boys, also illustrated lectures to the foreign-born on citizenship, history, commercial geography, heroes, traveling, etc., offer further opportunities for educational service of an extension nature. Musical entertainments with explanatory lectures have been introduced in a number of instances. The Curtis Publishing Company, of Philadelphia, has from time to time secured the co-operation of some of the most prominent musicians and opera singers in the world in this connection.

Rest Periods and Luncheons

Realizing the influence of pleasant surroundings during meals on the digestion and temperament of employes, an increasing number of industries is providing attractive luncheon-rooms instead of compelling employes to eat in alleys or around their machines and work-benches. Where no luncheon service is provided, tables can be furnished in a well-lighted room decorated

with a few plants and pictures. Arrangements can be made for warming the soup, coffee, and tea brought by the men.

Naturally, the next development of the luncheon-room would be the providing of hygienic lunches designed to give the greatest nutritive value combined with palatability and low cost. Indigestion due to unbalanced noon lunch is pretty nearly a universal affliction together with lack of nourishment ascribable to the omission of certain essential food factors.

A phonograph will provide recreation after luncheon, while a reading or rest room will prove a welcome addition, especially for women workers. A system of rest periods of 15 or 20 minutes' duration in the middle of the forenoon and afternoon has been found to pay for itself in many industries.

Social Activities

Receptions and socials in social centers such as schoolhouses near the shop can be conducted under the auspices of a committee of employes who will arrange a program and use as much of their own talent as possible. Such occasional receptions, together with weekly musical entertainments or illustrated lectures, will help counteract the ill effects of saloons and commercial enterprises. "Smokers" for the men, dances for the young women and their friends, and the celebration of national holidays are among the social activities which have been successfully carried out.

In order to increase interest in the home, prizes may be offered for the best back-yard, the best vegetable-garden, the best flower-gardens, and the best window or porch boxes of flowers. There may also be competitions in cooking, baking, and dressmaking under the auspices

of social clubs, to the maintenance of which the company will contribute. Figures 80 to 85, inclusive, illustrate social-welfare projects.

Medical and Hygienic Activities

Matters of sanitation, ventilation, and light have already been considered in connection with the original lay-out of the plant. Figure 86 shows the system of furnishing pure air employed at the Ford shops. It is necessary, however, that the employes be instructed in the principles of controlling these matters, in order that they may not interfere with the carrying out of the intentions of the management in the shop, and that they may also apply these principles in their homes.

The employment of visiting nurses is a service which can well be undertaken by a number of industries cooperating. Lectures on sanitation, hygiene, first-aid to the injured, and sex education, the providing of a company physician who will make a medical examination of all applicants for work as well as a periodic examination of all employes, and who acts as the family physician of members of the benefit society, are all activities which come under this head. Figure 87 shows a well-equipped emergency hospital.

Physical Training

Nearly all normal persons take pleasure in participating in athletic games and competitions. Baseball always appeals to a considerable proportion of the men, and it is usually easy to organize one or more teams. A comprehensive plan, however, will attempt to provide some kind of exercise involving the game idea to be participated in by practically every employe; hence, such a plan will include such games as basketball, football, soccer,

and track athletics. An athletic committee can supervise athletic sports at the noon hour in the factory yards or grounds, twilight or Saturday afternoon games, the conducting of field day sports, and the carrying on of calisthenic exercises during the morning, afternoon, and rest recess.

The same committee or a special committee can carry on extension work, so as to provide exercise for the younger children of employes' families, such as evening games in vacant lots and the promotion of playgrounds under the supervision of local schools or park authorities.

In case there are women employes, a women's athletic and physical culture committee should be appointed. It will be found that they will take as active an interest in competitive physical games as do the men.

Excellent help can be secured in this field from local Y. M. C. A. organizations and the Industrial Department of the Y. M. C. A. in New York City.

Suggestion System

The benefits to be derived from a well-conducted suggestion system have already been pointed out several times. Among them are not only the direct benefit of the improvements suggested, but encouragement of initiative on the part of the employe. Influencing him to think about things the company can do in better ways will develop a frame of mind and disposition worth collectively in many ways fully as much as the improvements actually installed as a result of suggestions.

The usual manner of encouraging suggestions is to provide boxes similar to mail-boxes at various points of the establishment, marking them conspicuously "Suggestion Box." Near the box are placed pencil and pad

with carbon paper, so that the employe may retain a copy of his suggestion. Copies of rules controlling the suggestion system are usually posted on or adjacent to the boxes. The contents of the boxes are collected at regular intervals and submitted to committees. It is usually desirable to classify the suggestions into various groups, such as:

1. Machinery and tools.
2. Health, safety, and general welfare.
3. Savings improvements in non-machinery processes.
4. Improvements in shop and office systems.
5. Suggestions for advertising.

Each individual case will suggest a modification of the foregoing grouping.

In order to pass intelligently and with judgment on the suggestions, it is desirable to have each group referred to a committee especially competent to pass on that group. It is also desirable to offer prizes in each group as well as additional prizes for the suggestions which result in the greatest economies or profits within six months or a year after their adoption.

Benefit Societies

Benefit societies have been conducted for a good many years as local organizations in a great many industrial companies. The original aim of most of these societies was the providing of insurance in case of accident, sickness, or death. Within recent years a great many states have passed compensation laws whereby the state, the corporation, and employe share the burden of compulsory insurance to provide for compensation in case of accidental injury or death.

Where such compensation laws exist, there still remain many enterprises which can be conducted under the auspices of company benefit societies. Among these may be mentioned the providing of insurance in case of sickness on the part of a member or any of his direct family, and the providing of vacation and Christmas funds. Frequently the benefit association will plan for special rates for vacation trips, camps, and similar undertakings.

The benefit association will sometimes also act in the capacity of a savings bank. This does not mean that the association actually engages in a banking business. It simply encourages the making of small deposits by providing convenient places of deposit and by means of notices on the pay envelopes calling the men's attention to the desirability of making deposits, which funds it turns over to a reliable banking institution. The benefit organization acts only as an intermediary and supplementary agency, so far as actual banking is concerned.

The usual amount of insurance consists of half-wages for as long as a year, if necessary. In case of illness or accident, the tendency in America is to grant this insurance only if the accident occurred while on duty. British or European compensation systems care for the workmen of small means, even if the accident or disability occurred while off duty.

In case of death, the tendency in America seems to be to allow one year's wages for death from sickness or accident happening while off duty, and two years' wages for death due to accident while on duty.

The ratio of the cost of insurance to the total payroll runs from 1½ to 2½ per cent. In many cases the management undertakes to bear a part of this expense. The Lodge and Shipley Manufacturing Company uses

the premium wage system, in which the workmen are paid one half of the money value of the time saved, and distributes the other half of this fund in such a way that part of it goes to the foremen, part to the clerical work of the premium system, and part into tool and equipment funds, while the remainder goes into the benefit and old-age pension fund.

TEST QUESTIONS

1. What are the aims of welfare, betterment, and social service work in industry?

2. Give a list of the activities ordinarily included under welfare and betterment work.

3. How can we best assign and organize welfare and betterment activities?

4. Discuss some of the features to be considered in connection with safeguarding.

5. Discuss briefly the principal considerations relating to fire prevention.

6. Discuss in general the question of educational activities to be carried on by industries.

7. Give statistical figures to show that it pays to undertake systematic safety work.

8. Discuss the advantages of rest periods and luncheons.

9. What are the advantages of social activities promoted by an industry?

10. What benefits can be obtained from medical and hygienic activities?

11. Discuss physical training and athletics as a part of welfare work.

12. What are the main points to be considered in installing a suggestion system?

13. Describe the organization and aims of industrial benefit societies.

14. How may we secure the co-operation of employes and prevent suspicion and indifference with regard to welfare work?

15. What are the arguments in favor of paying attention to the home life of employes?

16. Discuss the advantages to be derived from publishing a little house organ in which are presented accounts of the company's safety, welfare, and social activities.

17. Discuss the relationship between poor illumination and accidents.

18. What sort of co-operation by local and state school authorities would you advocate in connection with educational activities in industries?

19. Where state compensation laws are in existence, what activities can be undertaken by local industrial benefit societies?

20. What would you consider the requirements of a good industrial welfare supervisor?

CHAPTER XVI

EMPLOYMENT PROBLEMS

Desirable Qualifications of Employes

Some years ago the author made an extensive canvass of employers of technically educated young men to get from them the particulars as to the qualifications which they considered desirable. The replies included a great many characteristics. Some of these are in direct conflict with each other and could not exist in the same man. The complete list is as follows:

Address
Appearance
Neatness
Energy
Vitality
Speed
Concentration
Observation
Reason
Application, diligence, and industry
Accuracy
Punctuality
Economy
Order and system
Knowledge
Intuition
Culture
Prudence
Grit and tenacity
Tact and diplomacy
Judgment and fairness
Reliability
Steadiness
Loyalty
Integrity
Thoroughness
Initiative
Adaptability
Optimism
Cheerfulness
Reserve
Enthusiasm
Sincerity
Sympathy
Self-control
Ability as detailist
Ability as generalizer
Obedience to acknowledged authority
Ability to know men
Ability to get along with men
Self-confidence

ADDRESS, APPEARANCE, AND NEATNESS

A man who shows attention to his appearance in such matters as a clean-shaven face, neatly trimmed hair, well-brushed clothes and shoes, and general cleanliness, is pretty sure to have well-developed self-respect. He is quite likely to be neat in his work. If he is of pleasing address, that is, agreeable in meeting strangers, in asking and answering questions, and not rough, uncouth, or boorish, he possesses qualities which are of value in contact with other men. An employment manager can easily determine these qualities by a general look-over of applicants.

ENERGY, VITALITY, AND HEALTH

From a philanthropic or charitable standpoint, the insistence on these qualifications as necessary characteristics of new employes would debar many persons who are deserving in many ways. Labor organizations are already protesting against the establishment of health standards by various large corporations as a prerequisite to employment. In reply to this objection the employers state that the medical inspection is intended to eliminate only such new employes as would be likely to be a menace to others by reason of their having infectious or chronic diseases, or organic weaknesses which would make them charges on the company's benefit societies. The stress which is being laid by employers on these qualifications should serve to emphasize both the importance of engaging in systematic physical training and the avoidance of habits which tend to destroy health, energy, and vitality.

SPEED

For certain classes of work speed is an indispensable requirement. This is especially true of work which is

essentially routine, such as accountancy, stenography, and clerical work in general. In the lighter mechanical processes, where large quantities of light material have to be handled by hand, speed is also necessary. Some people are able to acquire a high speed of manual and mental activity without its being a strain. It is this type which is best adapted to this class of work.

The author has seen employes whose temperament was such that they could not stand a degree of speed normal and easy for others. Certain well-meaning friends of labor lay entirely too much stress on the wear and tear of speed in industry and clerical work. Any person who has had experience in kindergarten work realizes that speed is a natural gift and must be natural without any effort or fatigue.

The question of determining whether an applicant has the necessary speed required for a given position may be determined by simple mechanical tests. The lack of speed is by no means an indication that the applicant is undesirable, since there are certain other qualities fitting men and women for the highest kind of positions, which do not go with the temperament frequently possessed by persons capable of high speed. Failure in a speed test need not involve discouragement further than arises from the loss of the immediate position desired.

CONCENTRATION

The ability to give continuous conscious attention to a certain line of effort without allowing the mind to wander, or become distracted, is in most cases the result of good school training and discipline. The continuation of this habit by persons who have completed their schooling depends a good deal upon the ambition of the individual, or self-satisfaction. An elementary test for con-

centration would be to require the applicant to do a fairly complex arithmetical problem in a short time under conditions which would tend to distract attention. If the ability to concentrate is demanded for a position of pretty high grade, the only way to determine the applicant's ability in this line is to inquire from others. If he has been on the company's pay-roll, possibly a report is on file in regard to this qualification.

OBSERVATION

Some superintendents and foremen have the reputation of being able to spot any slight defect or inaccuracy, or infraction of the rules, if they make a casual walk through their shops or department. Such men may be said to have a pronounced degree of ability to observe. A skillful employer can form judgment on the observational ability of a man by spending a lunch hour with him and leading the conversation in directions which will draw out the desired information.

REASON

An employe who has been recommended as worthy of a high grade in reasoning ability is not likely to be subject to the so-called psychology of the mob. He is apt to think before he decides. A conversation carried on by a skilled employment manager will soon determine whether an applicant jumps at conclusions or bases on reason his replies to questions.

INTUITION

Intuition is closely related to observation and reason. In its crudest form it consists of what are believed to be racial fears, dislikes, and likes. The term is also used to express the possession of the power to form

judgments without any apparent application of observation and reason. The practical value of intuition consists in the ability of an individual to feel without reasoning, as it were, what persons are scamps and what persons are honorable; to know, without thinking or reasoning, what sort of acts on one's own part are creditable and which ones are discreditable.

A good many conclusions with regard to the intuitive ability of an applicant can be gained by large corporations which conduct a trial department such as is carried on by the Curtis Publishing Company. Under these arrangements applicants are paid during the period under which they are on trial. During this time the employment manager has ample opportunities to form judgments in regard to many characteristics of the applicant.

APPLICATION, DILIGENCE, AND INDUSTRY

The most desirable worker in the long run is not the one who accomplishes brilliant results by occasional spurts with intervening lapses characterized by inefficiency, but the one who maintains a uniform, steady, non-strenuous pace. Consultation with former employers will give some information as to these qualifications. Such information, however, is not always reliable. Moreover, it is necessary that the kind of work be one in which the employe takes an interest and to which he is adapted before any general judgment can be passed on him in regard to these qualifications. However, the employe who knows that he is being observed and is ambitious for promotion is likely to apply himself. Where a labor and employment bureau maintains records as to the efficiency and characteristics of men, it is worth while for the manager of such a bureau to

compare with the reports of foremen and department heads his opinion based on observation and he should make careful inquiries in case his own opinion is different from the reports.

ACCURACY

This is one of the qualifications in regard to which data can be secured by the test or examination process. While this qualification is extremely important in such work as is connected with pay-rolls, invoices, costs, time records, and accounts in general, there are classes of work in which, though desirable, it is secondary to other characteristics.

PUNCTUALITY

One naturally thinks of the time clock as the most reliable source of information regarding punctuality. There is, however, a higher degree of punctuality than that involved in promptly coming to work. This consists in the getting out of required reports on the scheduled date; in coming to committee meetings on time; and in seeing that any documents, work, or material which must be passed on to others are conscientiously taken care of.

There are many men of unquestionably high grade who resent being gauged by the time clock records of their arrival in the morning and after lunch time, but who are extremely conscientious and punctilious in seeing that no work is retarded nor any person delayed by their failure to meet their engagements and appointments promptly, or to get out and pass on work on time.

ECONOMY

The use of a short pencil may be a sign of slovenliness instead of an indication of economy. The same is true of

the use of a defective pen-point or a worn-out drill or cutting-tool. True economy consists in attaining the greatest output with the least expenditure. The use of worn-out carbon papers by stenographers is considered by some employers as a sign of carelessness rather than of economy, since time and eyesight are saved by clear copies. In comparing various foremen in order to determine which one shows the greatest economy, it is desirable not to compare one department with another in such matters as cost of sweeping, helper's time, repairs, and in general, the relation of indirect to direct labor, but to compare each department's records of expenditures related to output month by month and the same month in one year with the same month in a previous year.

ORDER AND SYSTEM

A man may be neat and still not be systematic. For instance, in a foundry the flasks may be piled very neatly in the yard, but in such a manner that there has to be a great deal of unpiling and repiling as well as walking a considerable distance, where a little less neatness and a better system would have resulted in higher efficiency. An observant foreman, superintendent, or labor supervisor will soon notice which employes can organize and systematize to the best advantage the materials and tools they have to use. Here again a man deserves recognition who is able to save himself from useless strenuousness and exertion by the application of ability in planning order and system for his own work.

KNOWLEDGE

In employing a man to do the work of a given trade, it stands to reason that knowledge of that trade is essen-

tial. The same is true of such work as accountancy and stenography. However, a knowledge of the particular business in question, obtained in a competitor's establishment, is sometimes a decided handicap, since the newcomer will find difficulty in adapting himself to different methods. There are many successful sales managers who prefer to competitors' salesmen those previously employed in selling a line entirely different from the one which they are to sell.

CULTURE

Gentlemanliness and refinement are necessary qualifications of men who are to receive visitors and salesmen. Courtesy is a quality which is characteristic of most well-managed shops, even in the roughest kind of construction work. One can notice effective results accomplished by foremen who are strict disciplinarians, but in no sense bullies.

PRUDENCE

In a general way this quality means that its possessor will be cautious, that he will be careful to look before he leaps. The American Revolution was won by the skill of Washington and Greene in always knowing when to retreat and in turning possible defeat into ultimate victories.

GRIT AND TENACITY

These are among the most important qualifications of gang bosses and foremen, who will be called upon to stand their ground unflinchingly. These qualities should characterize any men on whom is placed the responsibility of carrying into effect any changed or new processes or systems, since they will have to overcome the opposition of habit and prejudice.

TACT AND DIPLOMACY

Department heads and supervisional officers must be able to handle employes who are temporarily upset by ill-temper, misunderstandings, ill-health, family troubles, or other unfavorable influences. They will have to adjust many differences of opinion in a way which will still maintain them in the esteem of all parties to the controversy. Popular fiction abounds with stories of international and industrial intrigue in which diplomacy is pictured as duplicity. Successful business in America is characterized by fair dealing. A fair deal does not mean, however, that the employer needs to show his hand to his adversaries.

JUDGMENT

In order to pass judgment a man must have what is designated as the "judicial temperament." He will secure evidence and weigh it before he comes to any conclusion. Authorities have been known to postpone their decision on important matters, in order that they might be sure they were giving proper consideration to the subject. Good judgment is an essential qualification of anyone who is occupying an executive position.

RELIABILITY AND STEADINESS

These terms are really an addition to a to-be-taken-for-granted essential, honesty. A man may be honest enough to keep out of jail, but it is a higher degree of honesty to be dependable in all statements, in the fulfilling of all duties, and in steadfastly adhering to them.

LOYALTY

A man is disloyal who makes mean or derogatory statements about his employer or the business in which

he is engaged. There is no disloyalty in constructive criticism made to the right persons and in the proper spirit. It is this quality, more than any other, which will result in a man's promotion to the very highest positions in business.

INTEGRITY

Integrity is also another addition to the so-called honesty which is presumed to be possessed as an essential characteristic by every applicant. Integrity means unswerving resistance to any evil temptation, the ability to stand one's ground for honest principles in the face of opposition and intrigue. This qualification is an essential for every employe in the cashier's department, the purchasing department, and store-rooms, and also for men engaged in demonstrating time-study and rate-fixing work.

THOROUGHNESS

To be thorough in industrial work a man must be able to do things quickly, accurately, and economically. Thoroughness, as a mental qualification, makes its possessor "go the limit" to know all about any position or any undertaking. He will not do a job partly and then quit. Thoroughness is an essential qualification for a good foreman.

INITIATIVE

This quality is closely akin to inventive ability with the addition of enterprise. The possessor of initiative will find a way to overcome difficulties. He will not only dream of new ways of doing things, but will actually put them into effect. Initiative is an essential qualification for a designer, a tool-maker, or a systematizer.

ADAPTABILITY

This quality, in order to be a desirable one, does not mean that its possessor is willing to hang his hat anywhere, to engage in any kind of work with laborers of any nationality. It means that he will do all of these things, if compelled by necessity. To be adaptable means that a man is a "good mixer." This quality is necessary for a salesman or promoter.

OPTIMISM AND CHEERFULNESS

A man who emphasizes the positive rather than the negative, who emphasizes the good rather than the bad, who is of a pleasant temperament rather than morose or disagreeable, is a desirable employe. Optimism and cheerfulness radiate contentment in a contagious way. Similarly it is true that disagreeableness and "grouchiness" radiate discontentment.

RESERVE

A man with this quality will not be forward nor familiar. He will be the possessor of dignity. This quality is necessary in timekeepers and watchmen. A certain amount of it is necessary for supervisional officials, but not enough of it to amount to aloofness. Too much reserve in an official is almost as undesirable as insufficient reserve.

ENTHUSIASM

A man may be loyal, but lack enthusiasm. Enthusiasm is contagious and has won as many industrial victories as it has athletic contests. Employers who take their employes into their confidence, who give them illustrated lectures on materials, methods, and markets connected

with their business, and who aim to make the employes feel that they are an essential part of the business, will do a great deal towards arousing enthusiasm.

SINCERITY AND SYMPATHY

These qualities are indispensable in all employes who are to be engaged in social service, welfare, and betterment work. Persons who have undertaken such work merely to form the acquaintance of wealthy or influential people, or as a fad, are sure to make a failure of it in the long run.

SELF-CONTROL

This quality is shown in a man's temper and in his habits. It is particularly necessary for any employes who are apt to be subjected to trying conditions, and it is absolutely indispensable to an exchange clerk or trouble clerk in a large department store, gas or electric light office.

ABILITY AS DETAILIST OR GENERALIZER

In cost department work ability as a detailist is exceptionally desirable in the work of making entries. When it comes to making up graphical reports and comparisons, ability as a generalizer is required. The two qualities are seldom combined in the same person.

OBEDIENCE TO ACKNOWLEDGED AUTHORITY

Like adaptability, this quality is of highest value when it requires some conscious effort on the part of one who is subjected to the authority in order to be obedient. An employe who follows like a sheep in a flock would be just as likely to follow an unprincipled leader by reason of his weakness. The ability to realize the necessity of

obedience to authority on the part of an otherwise high-spirited man is an indication that he himself will probably make a good leader.

ABILITY TO KNOW MEN

This ability is partly intuitive and partly acquired. It cannot be acquired wholly through a study of books on psychology. A good many employers have a great deal of confidence in their own ability to size up a man in a very few minutes. As a matter of fact, it is possible to secure in a brief interview reliable data in regard to some few qualifications. It is quite likely that these men who size up an applicant so quickly, concentrate on three or four qualities such as address, appearance, reserve, and vitality. There is no occult power which enables one to secure information with regard to such qualities as diligence, order and system, or initiative, for example, by means of a brief interview.

ABILITY TO GET ALONG WITH MEN

This trait includes a number of qualities such as tact, cheerfulness, and sympathy. Still, a person may possess all of the foregoing qualities and yet be so absorbed in his work that he cannot drop the absorption for a long enough period of time really to get acquainted with the human side of his associates. A friendly disposition and tolerance of other people's prejudices and eccentricities are desirable in this connection.

SELF-CONFIDENCE

This is an essential quality for every leader, whether he be a gang boss on construction work or works manager. This quality should by no means be confused with an exaggerated idea of one's own abilities, which will

lead to disaster far more quickly than timidity or a lack of self-confidence. If a man, having received adequate education and training, is considered capable of a new assignment given him, and on reflection he finds nothing that should prevent his succeeding in the undertaking except timidity, or inertia, he should welcome every new experience as an opportunity to develop the desirable quality of self-confidence.

School and Education Record

Modern school records cover a considerable line of data which should be of material assistance to an employment manager in forming correct estimates of applicants. Such records reveal facts as to punctuality, application, conduct, proficiency in various branches, and time of leaving school. Inquiries as to the kind of studies the applicant likes best or least and the kind of reading he at present enjoys, are frequently useful.

Family History

Data with regard to the father's occupation, health, nationality, number of brothers or sisters and their occupation, are also useful.

Industrial History

It is desirable to secure data in relation to the previous jobs or positions held by the applicant, the length of time he held them, his reasons for leaving, employer's reasons for the leaving, the amount of earnings at the various jobs, and likes and dislikes in regard to the various jobs.

Housing and Thrift Data

Henry Ford lays great stress on the general character of the residence or home condition of premises, orderly

condition of rooms, home sanitation, cleanliness, attention to appearance and education of children, amount of savings in bank, and ownership or non-ownership of home or building lot. In fact, the foregoing information, if satisfactory, forms the chief basis of the Ford Company's putting a man in the so-called five-dollar-a-day class of American citizens.

Co-operative Employment Agencies

From the foregoing list of qualities, which one needs to consider before passing judgment on an applicant for employment, it is quite apparent that a good deal of needless expense accrues when an employer endeavors to determine for himself and to keep on file in his own employment department written data with regard to various applicants for positions. This energy should be concentrated on accumulating additional facts and data in regard to employes already at work. A central public employment bureau can advantageously gather together most of the foregoing data, so far as they relate to unemployed persons or young persons just beginning to work.

Is there an All-round Man?

The very length of the above list of desirable qualities gives a negative answer to this question. Our problem, then, is to select those particular qualities which are most important for a given job or position, and then find among our applicants the one who possesses the special qualifications for the work at hand.

Union or Non-union Men

The Supreme Court rendered a decision in February, 1915, which stated that it is the inviolable right of every

employer to decide whether he shall employ union men or not. Where a company must employ men who have served their apprenticeship and have had their experience in skilled trades, it is very likely that it is easier to secure union men than non-union men. If it is at all possible to have all union men or non-union men in a given trade or department, such an arrangement is generally more desirable than one in which part of the men in a department are union men and part of them non-union men.

If the employes in a given department are non-union, or an attempt is to be made to employ either union men or non-union men, the minimum-wage scale should be the union rate. In order to avoid hostility on the part of organized labor, it is desirable at all times to pay as a minimum wage the union scale, reserving the right to pay any additional bonuses for increased efficiency and reserving also the right to select one's own employes as well as to direct the manner in which work is to be done. In a shop in which there are both union and non-union men, when a proposal as to new methods of management is explained to the men and is submitted to them for an expression of opinion, it is usually desirable to have the groups of organized labor consider the proposals and report on them independently of the employes as a whole.

It sometimes happens that union employes in a shop in which pleasant relations exist between the men and the management may be entirely willing to accept bonuses or premium-wage systems over and above the union scale, but will not be permitted to do so by the vote of the other members of their local union. Under these circumstances arrangements may be made whereby the bonus will be allowed to accumulate to the credit of each man

and be paid to him in the form of an increase in his hourly rate. This arrangement should satisfy all parties.

Organized Labor and Scientific Management

In February, 1915, riders were attached to the army and navy appropriations prohibiting the making of time studies of the movements between starting and completing any job of work done by an employe in any arsenal or navy yard. Any violation of this prohibition shall be punished by a fine of $500 or by imprisonment for six months.

These riders are the result of aggressive propaganda carried on by representatives of organized labor. The reasons for their attitude are stated as follows, by Mr. Keating, of the Committee on Labor:

> The tendency of so-called scientific management through the timing (stop-watch) and bonus features will be to aggravate further the accident disabilities and mortality among American workmen and to reduce the workman to a mere mechanical instead of a social and moral relation to his work, and, moreover, it is unnecessary in order to secure adequate efficiency of labor. The Taylor system regards the workman as a machine to be "speeded up" to its maximum capacity. When this human machine fails to function to the satisfaction of the management, it is to be cast aside to make room for a new machine—a fresh workman. The authors of the system do not appear to have concerned themselves about the ultimate fate of the human derelicts who may be compelled to drop out because they can not stand the pace. Mr. Taylor boasts that, when he installed his system in the Bethlehem Steel Works, he purposely made the tasks so hard that "not more than one out of five laborers (perhaps even a smaller percentage than this) could keep up." That may be the kind of "efficiency" which produces dividends for the Steel Trust, but it is surely not the system which a beneficent Government should force upon its employes! The main object of the

Taylor system, and of all its related "systems," is to produce the maximum of output at the minimum of expense. The so-called bonus or premium system is a fraud and a snare. It really operates to reduce the workman's wages, not to increase them, as the proponents of the Taylor system maintain.

In reply to the above charges the advocates of scientific management claim that making time studies has nothing whatever to do with "speeding up." Time and motion studies disclose the expenditure of useless energy and wasted time. Attainment of safe conditions and avoidance of fatigue of any sort are among the avowed objects of scientific management. The statement that the Steel Trust does not concern itself with the fate of its employes needs no further answer than the illustrations of safety and welfare work carried on by this great corporation and shown in the half-tone pictures in this text.

Importance of Employment Bureau

The foregoing discussion gives us ample grounds for concluding that a capable employment manager is one of the most important officials of a large industrial corporation. There can be no universal system for selecting workers or keeping record of their characteristics. Each employment manager will have to develop such a system to suit his own conditions, and he can use his influence to further the establishment of central labor and employment bureaus where tests can be made and records kept of the qualifications of persons seeking employment.

TEST QUESTIONS

1. Discuss the advantages of pleasing address and neatness.
2. Is it fair to demand a clean health certificate from applicants for employment?

3. In what sort of work is speed an essential requirement?
4. What sort of positions demand concentration?
5. In what sort of work is keen observational ability desirable?
6. What sort of jobs require well-developed reasoning ability?
7. What sort of positions require the possession of natural initiative?
8. How may we judge as to an applicant's diligence and industry?
9. How may we determine as to an applicant's accuracy?
10. Why is punctuality an important factor in rating employes?
11. Distinguish between true and false economy.
12. What importance would you give to order and system in rating employes?
13. What kind of positions require a thorough knowledge of the business?
14. How would you define culture?
15. What kind of positions require grit and tenacity?
16. How would you proceed to train an employe to develop tact and diplomacy?
17. What is good judgment?
18. Why is loyalty one of the most essential qualifications of employes?
19. What is initiative?
20. What method would you adopt for classifying and testing applicants for employment?

CHAPTER XVII

REPORTS TO EXECUTIVES

Duties of the Modern Industrial Executive

There was a time when the only data available for the executive were those that were of a retrospective nature; in other words they were a record of past history. These data were expressed only in dollars and cents and in columns of figures. The duties of the old-time executive were to see that profits were made for current dividends, that results in this line were obtained regardless of methods.

The modern industrial executive must think, plan, and organize for the future. He gets from the sales division the probable demand, from the manufacturing division the probable output, and he determines the most profitable lines to manufacture. He aims at a definite selling and manufacturing program, and with these standards and plans as a definite goal, he works towards their achievement. In production he aims at many other things than immediate dividends. He must have data regarding the permanence of employment, increased efficiency, and earning powers as profit-makers of the various classes of employes, and he must aim at higher standards in these fields.

This involves reports and statistics containing much information which cannot be told in tables of dollars and

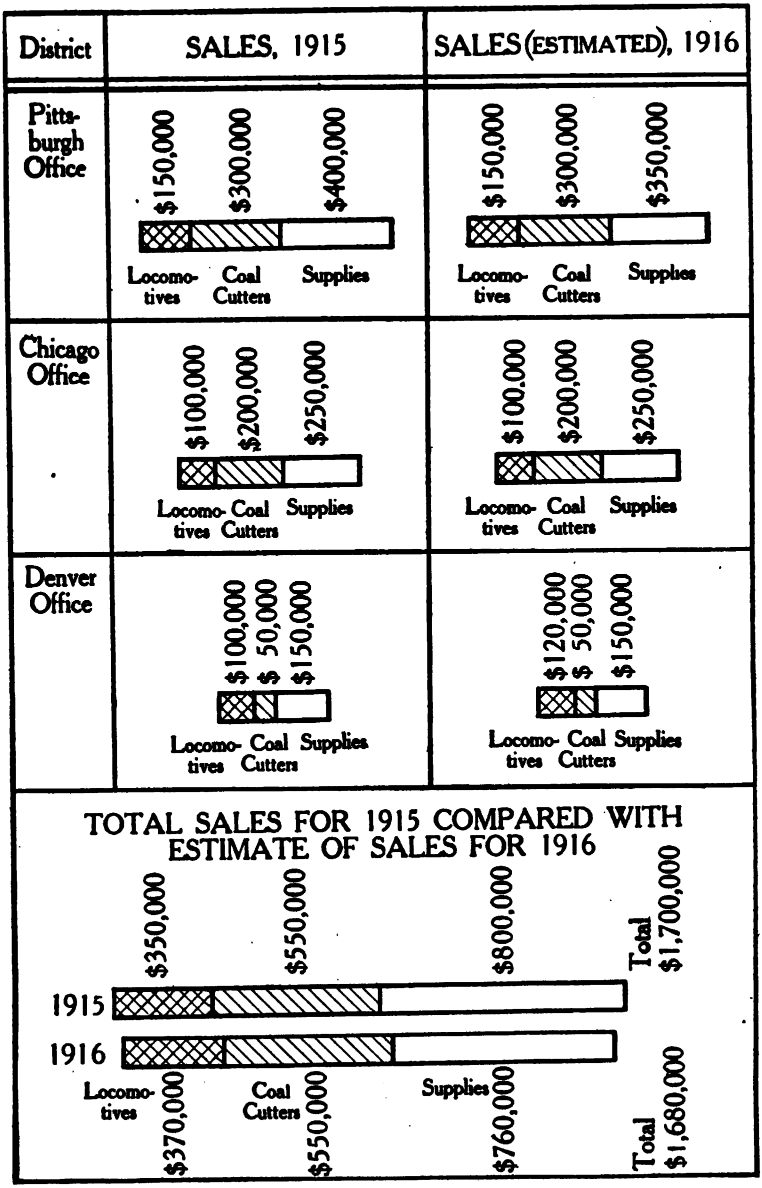

FIG. 88.—Sales Manager's Report of Last Year's Sales and Next Year's Demand

cents alone. It is only through the medium of systematic reports presented in such ways as to encourage independent conclusions that general and departmental executives can have clear-cut ideas as to existing conditions and needs for the future.

Selling-Division Reports

Figure 88 shows a sales manager's report of the past year's sales and his estimates of next year's demand. The next year's demand is based on carefully prepared estimates of the various sales offices. Note how the reports are made more striking by the simple graphical method used of drawing a bar to scale representing the figures which are inserted at right angles to the bar. The report of each of the three branch offices is given separately, while at the bottom of the sheet is the combined total of the reports from all three offices.

An investigation of the reports shows that the Pittsburgh office expects no increase in the business in locomotives and coal-cutters, and expects a decrease in the supply business. The Chicago office expects a business identical with that of the past year. The Denver office expects an increase in the locomotive and supply business, and no change in the coal-cutter business. The combined expectations for the next year show an increase in \$20,000 worth of locomotive business, the same volume of coal-cutter business, and a decrease of \$40,000 in the supply business, making a total decrease of \$20,000 worth of business expected the next year.

It seems as though the biggest decline anticipated is in the supply business in the Pittsburgh district. An investigation needs to be started at once as to whether this expected decline is due to competition of local repair shops which may be getting away some of the company's

supply business. Suggestions are asked as to how to prevent this. Among the suggestions offered is one that deliveries were not always prompt. This suggestion is followed by a request for a detailed classification of the supply business with estimates on next year's business. This is followed by recommendations as to the varieties of articles to make up for stock so as to be able to effect prompt delivery, especially on competitive items.

Predetermining Each Sales Territory's Earnings

Having prepared the selling program for each territory in the way of quantity of each style or variety of product, it is essential to list against the foregoing data the allowable manufacturing costs together with the share of administrative burden, and the allowable selling expenses for each territory. This will include the district sales manager's salary and expenses, salaries and expenses of all salesmen in the district, rent, insurance, taxes, clerical salaries, depreciation of office fixtures in the district sales office, probable expenditures for new office furniture and fixtures, stationery, postage, telegrams, advertising, and all other district sales office expenses.

This budget must be carefully scanned and compared with the selling program, with a view to showing the greatest possible profits in earnings. If it is desirable to try to modify the demand from a style which is not so profitable into one which makes greater profits, the local sales force needs to be informed thoroughly and coached to push energetically and tactfully the new line.

Reports of Actual Sales Made

Each salesman should make a daily personal report to the district office. The district office should make to the

main office a daily report covering sales made. A monthly report must be made showing the actual sales for the month together with the actual expenses of the district office and the predetermined manufacturing costs of the articles sold.

The main office will compare the selling expenses with the predetermined budget, and also the actual manufacturing costs with the predetermined budget. Those departments showing a record of having done better than the budget estimates should be encouraged by an expression of appreciation, and a thorough investigation should be made of departments failing to come within the budget limits.

Manufacturing-Division Reports

As soon as the manufacturing division has received the sales division's estimate of sales for the coming year, it will be necessary to determine at that time what probable shipments will have to be made. To open up this question, records of the previous year's shipments, arranged by groups, are desirable. Figure 89 shows in graphical form a statement of shipments of locomotives for 1914. This report is submitted to the sales division with the request that an approximate statement as to the probable dates of shipment of the various classes of product for the coming year be prepared by the sales division, and furnished to the manufacturing division. This information will serve as the basis for a tentative manufacturing program for the year, which will then be divided up into a tentative program for each month. At the beginning of each month the manufacturing and shipping program for the rest of the year and for the remaining months of the year will have to be modified to suit the requirements of actual sales. The general

manufacturing and shipping programs will form the basis of a good many subsidiary reports which depend upon them.

Detailed Parts Manufacturing Program

From the running inventory covering the balances on hand, manufacturing quantities, and consumption for

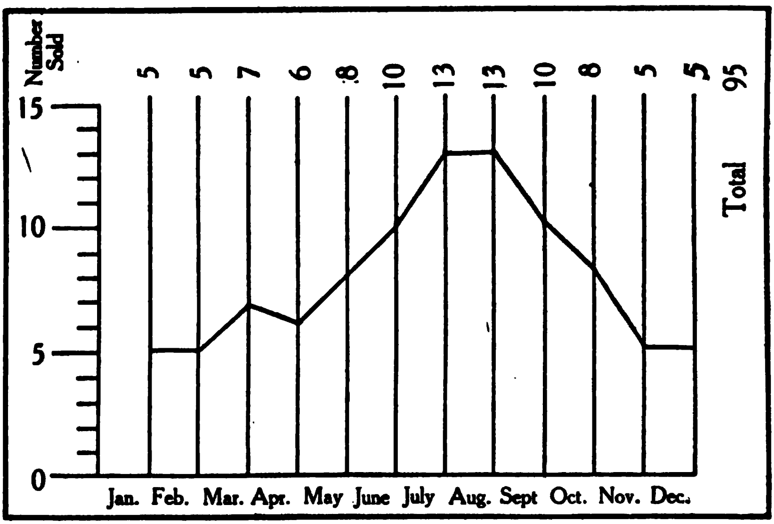

Fig. 89.—Shipments of Locomotives, 1914

manufactured parts, and for shipment as repair parts of various individual parts, annual and monthly programs will next be made up covering the manufacture of individual parts in quantities. The preparation of these reports will require the co-operation of the man in charge of the running inventory and balance of stores record, the man in charge of order of work and routing, and the shop superintendent.

Work for Each Machine and Production Center

With the detailed parts manufacturing program as a basis and past time records as guides, it is now possible to anticipate work ahead for each machine and at each production center. This information will serve as a guide for settling such questions as those relating to the advisability of purchasing additional machinery and tools, employing additional men, and enlarging work areas in the shops.

Classified Reports of Materials and Supplies

The foregoing reports will furnish information as to the total quantities of the following supplies to be purchased for the year: castings—iron, steel, brass, and copper; the various kinds of bar stock, bolts, nuts, screws, and hardware; and boxing and crating materials for the pattern shop, forge shop, and foundry machine shop. This annual program will have to be divided into approximate monthly buying programs, which will have to be modified from month to month. A statement of the probable money expenditure for materials and supplies together with times at which payments must be made will also have to be prepared.

Pay-Roll Estimates

With the previous year's pay-rolls and the current year's manufacturing program as a guide, estimates must be prepared of the number of men to be employed for the coming year, and this divided into monthly estimates. These reports must cover not only the number of men employed in the various departments, but also the amount of money required to meet salary and wage pay-rolls.

Comparison of Probable Money Income and Expenditure

With the foregoing estimates as to money required to meet bills for materials and supplies to be purchased, salaries and pay-rolls to be met, and further information as to money required to meet other expenses, such as dividends, taxes, insurance, rents, repairs, additions to buildings and equipment, graphical statements can be prepared showing money expected to be paid in and amounts which will probably have to be paid out.

A statement of this sort can be prepared in the form of curves in different colors of ink. For money expected to be paid in, black ink may be used; for money expected to be paid out, red ink can be used. This report may indicate that during certain months more money will have to be expended than is available for expenditure. This means that arrangements will have to be made to borrow money to cover such periods and in order to take greatest advantage of cash discounts. It is quite likely that money can be earned by borrowing funds from the bank, paying the ordinary rate of interest for the same, in order to take advantage of cash discounts. Two per cent for cash is a frequent discount, while 6 per cent per annum is usually all that will have to be paid for borrowed money. Figure 90 illustrates the probable form that such a report of money income compared with money outlay expected is likely to take.

Cost-Department Reports

The cost department should use the manufacturing program reports as the basis for plotting the labor, material, and expense costs of work to be done. These predetermined costs represent the limit beyond which the

shop must not go. In different-colored inks there will be superimposed on these curves at a later date the actual costs showing the savings made by cutting under the predetermined costs. A manufacturing establishment, in order to be progressive and to keep up with the times, must be constantly showing diminished unit costs. This

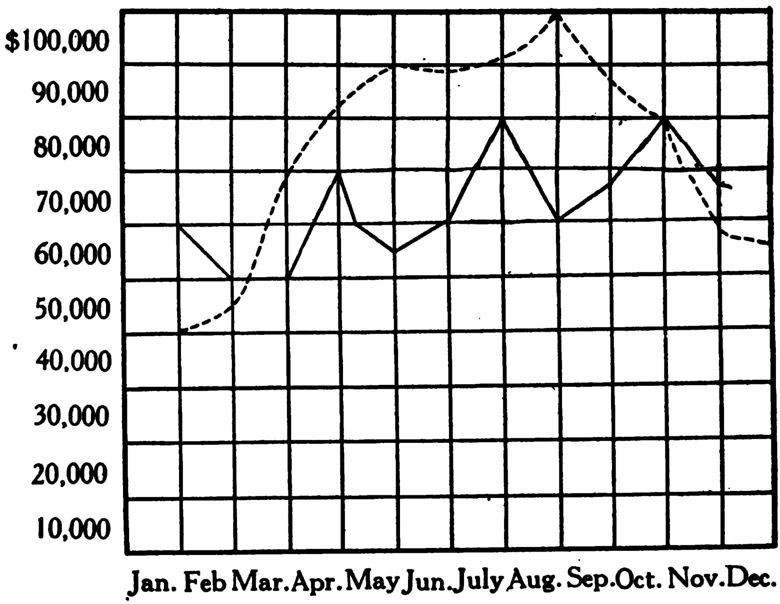

FIG. 90.—Money Income and Outlay Chart
--- Money receipts expected
— Money expenditures expected

does not signify that lower prices are paid either for materials or labor, but that improved methods and greater efficiency are being employed.

DETAILED EXPENSE BUDGET

The various subsidiary manufacturing expense accounts should be plotted separately. Previous records

of these classified expenses will serve as a basis for such advance budgets. Every person responsible for the incurring of expenses must have before him his budget which he dare not exceed and which he must constantly aim to reduce.

Reports of Suggestions

With the record of suggestions made in the past a statement can be prepared of the number of suggestions made in the various classes by members of various departments together with the prizes given for such suggestions and the estimated savings as the result of these suggestions, this being accompanied by a statement of the suggestions made, prizes awarded, and the anticipated savings to result from suggestions made during the current month and year. A statement of this sort may be advantageously published in a monthly paper to be distributed among the employes. Such a monthly publication may well be made a medium for arousing interest, enthusiasm, and loyalty on the part of employes. The Ford "Times" is an example of such a publication.

Profit and Loss Statement

The progressive establishment will have a profit and loss statement prepared every month, instead of only once a year. This statement will give in condensed form the gross earnings from all sources during the month, gross expenditures of all kinds during the month, interest on bonds, preferred stock dividends, common stock dividends, and financial surplus or deficit for the month. A graphical report of the above items may be advantageously prepared for each month of the current year as well as for the corresponding month of last year.

Physical or Non-financial Reports

Each industry will have its own peculiar physical data which need to be reported at regular intervals. Figure 91 is a typical report of this sort. It represents a weekly cupola report of a foundry, showing the number of kinds and corresponding percentage of each kind and amount of pig iron used, the total iron charged to the cupola, also supplementary material such as coke and manganese used, good castings delivered, the scrap, gaggers and clamps, flasks and bars, and total of all castings made expressed in pounds and in per cent; also the loss in the cupola in pounds and per cent.

Many similar data can be made the basis of physical reports. In the power-plant such matters may be listed as the heating value, volatile matter, and ash in the coal consumed, continuous record of unburned gases in the stack, pounds of water used by the boiler, pounds of dry steam delivered by the boiler, records of switch-board instruments, total pounds of coal burned, total pounds of ash removed, expression of the above data in unit ratios such as pounds of coal per kilowatt hour, etc.

The labor and employment bureau will make reports covering the number of men quitting, the number of men laid off, the number of men discharged, the total hours of regular time work, the total hours of overtime work, the hours and pay-roll for day work, the hours and pay-roll for piece work, the hours and pay-roll for premium work, the hours and pay-roll for bonus work, together with explanations of any notable increases or decreases. It should be borne in mind that mere figures are not of much value, but the relationship of the figures to other facts is important.

CUPOLA REPORT WEEK ENDING 4/30 1915

Kind and Grade of Pig Iron Used	No. of Pounds.	Per Cent
6% Si	9900	095
No. 1 Pig Iron	9900	095
No. 2 Pig Iron	39600	380
No. Pig Iron	—	
New Scrap	10400	100
Foundry Scrap	12800	122
M. Shop Scrap (New / Old)	—	-
Total	82600	79.2
Remelt Scrap	21700	208
Total iron to Cupola	104300	1000
No. pounds Coke used in Cupola	16820	16.12
No. pounds Manganese used in Cupola	1215	012
Castings made but not delivered (Mistake in Day)	600	008
Good Castings delivered	66961	894
Foundry Scrap	4465	060
M. Shop Scrap	344	004
Gaggere and Clamps	600	009
Flasks and Bars	1900	025
Total Castings made	74930	1000
Loss in Cupola [Excluding Remelt.]	5670	054

REMARKS:

NOTE:
Per cent of iron based on total charge.
Per cent of Castings based on Castings made.

FIG. 91.—Weekly Cupola Report

Accumulation of reports from which no definite conclusions are reached is a sure sign that such reports serve no useful purpose, and should be discontinued. The making of reports is a matter which can easily be overdone. At the same time, systematic reports disclose conditions which would otherwise not have been revealed. They serve as a spur to action where without them there would have been no incentive at all.

TEST QUESTIONS

1. Discuss the necessity of reports to the modern executive.
2. What are the advantages of preparing a selling program in advance?
3. How may we prepare a budget for each sales territory?
4. What sort of records should be kept as to the results obtained by each individual salesman?
5. What points have to be considered in preparing in advance an annual manufacturing program?
6. What data will guide us in our manufacturing program of detail parts?
7. What statistical data will lead to a sound judgment relating to the advisability of purchasing additional machinery, employing men, or enlarging work areas?
8. From what sources are data obtained to indicate the nature of the annual and monthly buying program?
9. From what sources are data obtained as to future pay-rolls to be made?
10. What sort of reports should be prepared to indicate the relation of probable money income to probable expenditures?
11. How may predetermined costs be made effective in holding down actual costs?
12. What statistics and data afford a basis for allotting expense budgets in advance in manufacturing departments?

13. What are the advantages of monthly balance sheets and profit and loss statements?

14. What data must be secured from cost and stores departments in order that we may have monthly balance sheets?

15. What are the advantages of graphical charts in connection with any of the foregoing reports?

16. What sort of physical or non-financial reports should be prepared by the foundry?

17. What sort of physical reports should be turned in by the power division?

18. What sort of reports should be made by the labor and employment bureau?

19. What sort of report can be made on the efficacy of a suggestion system?

20. How may we determine what reports are worth while and which ones are not?

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